Volume 28 JANUARY, 1922 Number 5

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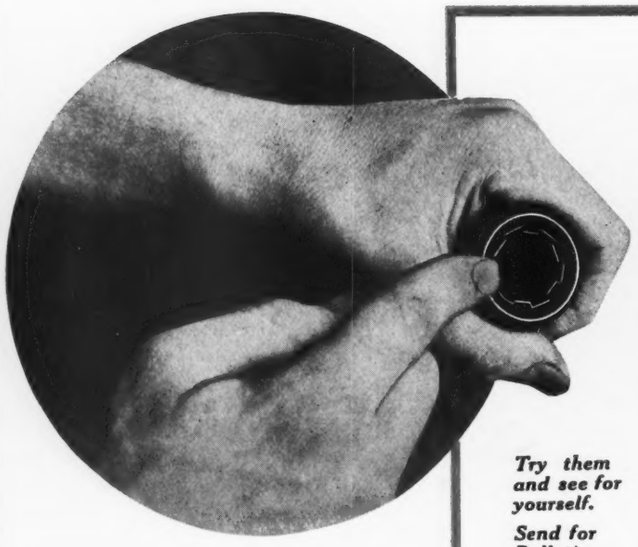

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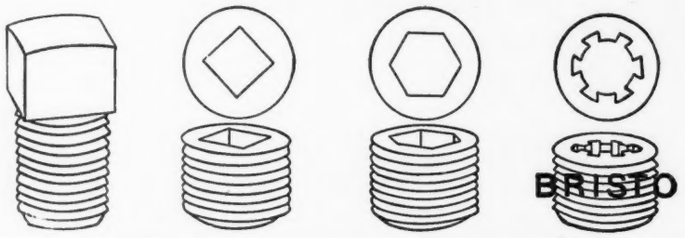

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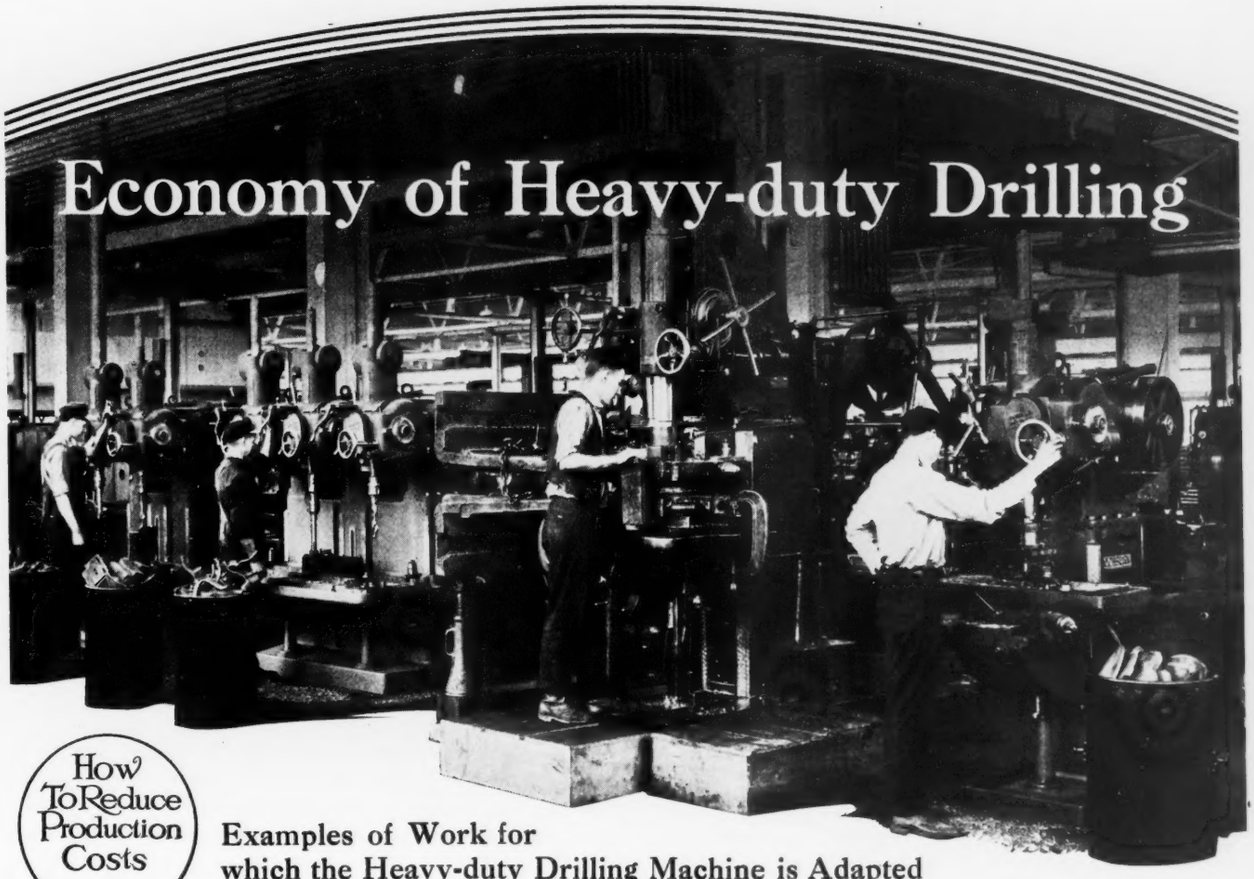
Economy of Heavy-duty Drilling



How To Reduce Production Costs ?

Examples of Work for which the Heavy-duty Drilling Machine is Adapted

By FRED R. DANIELS

THE heavy-duty manufacturing type of drilling machine is especially useful as a production machine when accuracy is one of the main considerations. In this type of machine the work is located on a substantial foundation so that it will withstand the thrust produced by the powerful drive. The present article deals with the use of The Colburn Machine Tool Co.'s heavy-duty drilling machine for work where heavy cuts are required. This machine is built either in single units or in gangs, and the examples here given include both types.

The two-spindle machine is particularly suited to machining work such as motor-truck axles, on account of the possibility of adjusting one spindle unit so that the center distance will agree with the spacing of the holes in opposite ends of the work, thus eliminating the necessity of reversing the work. One operator can handle the work alone. Fig. 1 illustrates the application of a two-spindle Colburn heavy-duty drilling machine for machining truck axles in the plant of the Timken Detroit Axle Co., Detroit, Mich. The operations consist of drilling and reaming the 1⅛-inch diameter holes at each end and counterboring a large hole in the lower arm of the steering-knuckle yoke. These axles are produced at the rate of four per hour. The arrangement for adjusting the center distance in these machines, when handling work of this class, is illustrated in Fig. 3. The dotted outline at the base shows the position when the minimum center distance of 44 inches is obtained. This may be increased to a maximum of 63 inches by simply turning the hand-wheel that actuates the right-hand unit through the medium of worm-gearing.

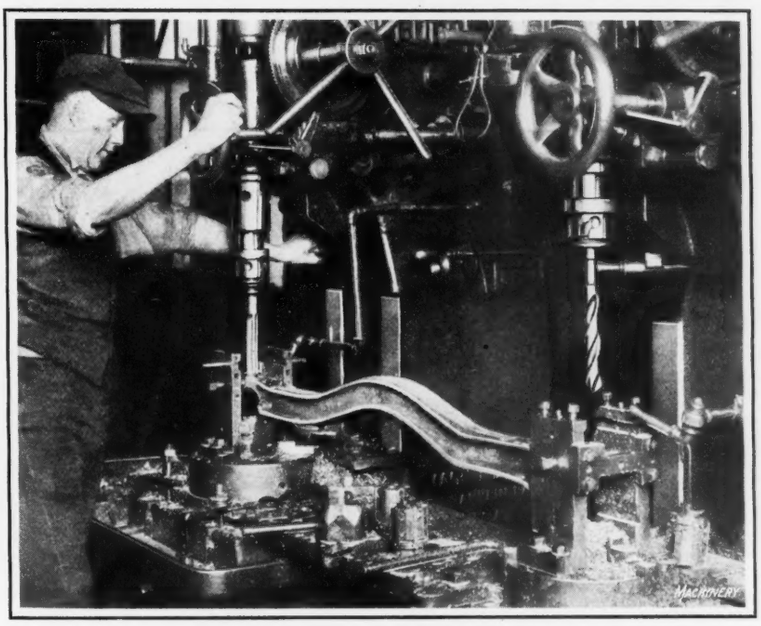


Fig. 1. Two-spindle Drilling Machine machining Motor-truck Axles

The three-spindle No. 2 Colburn manufacturing drilling machine illustrated in Fig. 5 is employed by the Tokheim Oil Tank & Pump Co., Fort Wayne, Ind., for machining cast-iron pump cylinders. The operations consist of boring, reaming to 3¾ inches

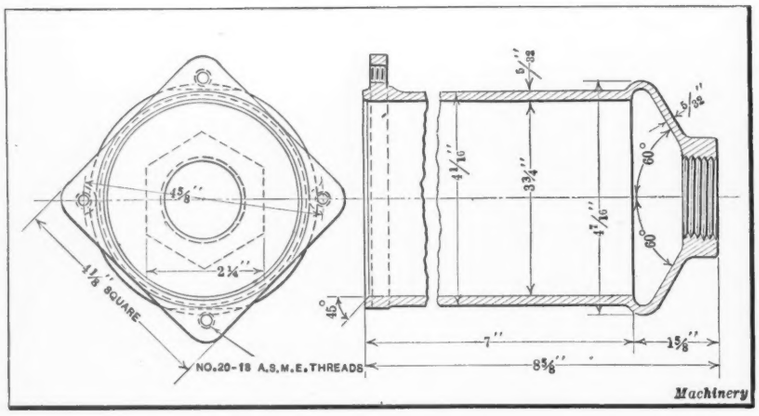


Fig. 2. Pump Cylinder machined with Set-up illustrated in Fig. 5

diameter, and facing the open end of the cylinder. A detail view of this cylinder is shown in Fig. 2, from which the nature of the work performed may be better understood. From Fig. 5 it will be seen that the cylinders are chucked in special sliding fixtures so that after the hole has been bored under the first spindle, the fixture may be slid forward to an auxiliary table, which carries it to the right, and it is then slid back under the second spindle for reaming. This arrangement enables the operator to keep the three spindles constantly at work and to so time the feed of each spindle that as soon as the work has been faced under the third spindle it can be removed and replaced with a rough casting, which is transferred to the first spindle to undergo the same series of operations. The track on which the fixture carriages ride extends at the end of the machine a sufficient distance to permit the end carriage to clear the end spindle entirely when unloading, so that the fixture carrying the reamed casting may be advanced for facing.

For driving large boring-bars, reamers, and other tools where a powerful drive is employed and the tools are run at their maximum recommended speed, the noses of the spindles are slotted to accommodate a driving lug on the shank of the tools. The spindle speed employed for the operation described in the foregoing is 80 revolutions per minute, and the feed 0.012 inch per spindle revolution. This special equipment enables a production of eight castings per hour to be attained. This job is not primarily a drilling machine operation; therefore, the increase of the output per operator by the use of this special drilling machine arrangement, lends considerable interest to the job from the aspect of reducing manufacturing costs through greater production.

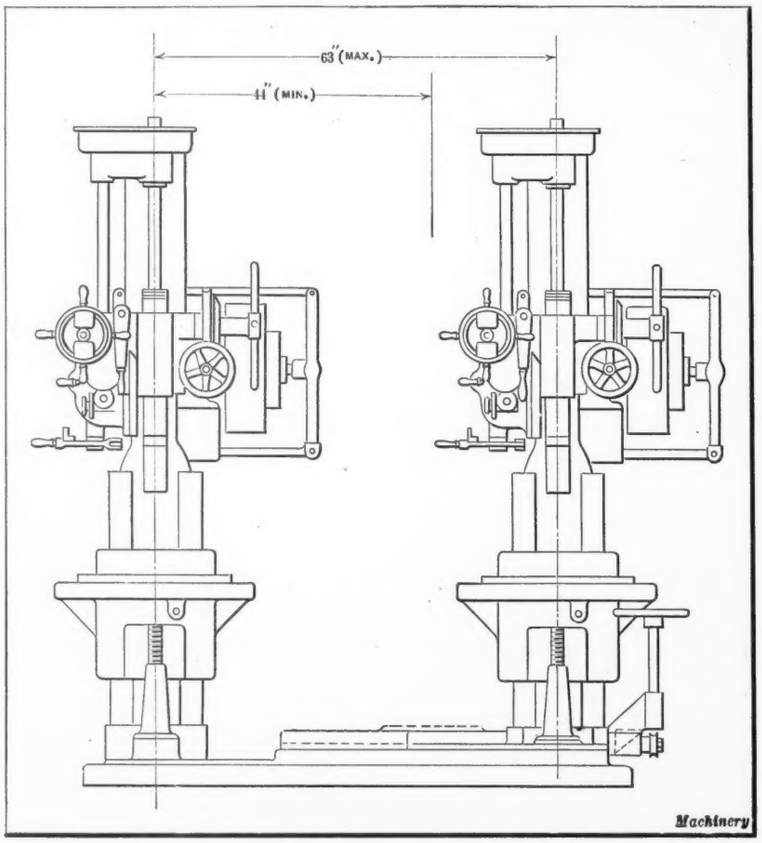


Fig. 3. Diagram showing Provision for adjusting Center Distance of Spindles

Cutting Acme Threads

The elevating screw nut used in the construction of the Colburn boring mill has a left-hand Acme thread, four threads per inch, which was formerly produced by chasing on a lathe. The work is now being performed on a drilling machine, using an angle-plate fixture to which the work is strapped, as shown in Fig. 6. These nuts are made of cast iron, and they are first drilled and reamed to 1.3125 inches in diameter, after which three taps (two roughing and one finishing) are run through the reamed hole to produce the Acme thread. The outside diameter of this thread is 1 9/16 inches. For drilling, a speed of 240 revolutions per minute is used, with a feed of 0.016 inch per revolution. For reaming, the speed is 45 revolutions per minute, and the feed 0.035 inch per revolution. The production time by this method of machining is six pieces per hour; whereas when the work was done on a lathe only seven castings were produced in a nine-hour day.

Machining Lever Brackets

For machining cast-iron lever brackets, such as those shown on the table of the machine in Fig. 7, a box-type jig is used which is designed to accommodate both right- and left-hand castings and also to permit the use of a box-tool for turning the end of one bearing on this casting. A plan view of this fixture showing the position of the casting, as well as the provision for handling opposite-hand castings is shown in Fig. 4. The work is located against one of the studs *A*, and is fastened to the side of the fixture by two hook-bolts *B* which reach over the foot of the casting and secure it in position after the set-screw at the end of

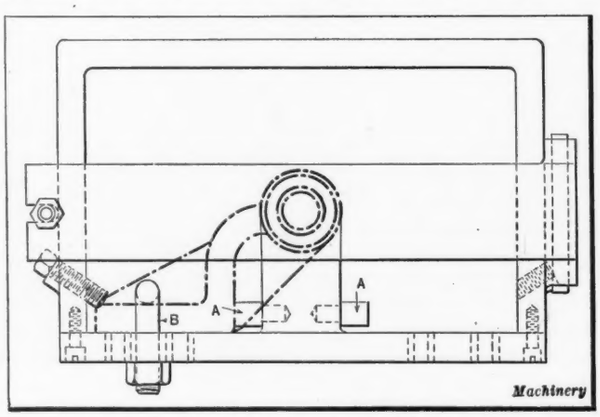


Fig. 4. Box Jig used in Operation illustrated in Fig. 7

the jig has been tightened against the end of the casting, locating it firmly against stud *A*.

With the work thus located and the cover fastened down, a hole 1⅛ inches in diameter is drilled and reamed through both bearings of this bracket, after which the cover is thrown back and a box-tool is employed to rough- and finish-turn the outside diameter at one end of the casting. This is the operation illustrated in process in Fig. 7. The diameter of this turned end is 2¼ inches, and the length 1¼ inches. The next operation is that of spot-facing the inside of each bearing, using a double facing tool which is fastened to the cutter-bar after it has been run down through the two reamed holes, so that the cutter is located between the two surfaces to be finished. The cutter is first fed up and then down, and its use assures parallelism of these two faces.

With the work still in position, the jig is turned on its side and four 17/32-inch holes are drilled and spot-faced in the foot of the casting. The jig is open at the back, so that as it is turned over, the chips fall out, thus overcoming the objection commonly raised to the use of box fixtures. For the 1⅛-inch hole, the drill speed is 300 revolutions per minute and the feed 0.018 inch per spindle revolution; for reaming, the speed is 45 revolutions per minute and the feed 0.035 inch. For turning the 2¼-inch diameter, a spindle speed of 160 revolutions per minute is employed with a feed of 0.018 inch per revolution. For the 17/32-inch holes in the foot, the drilling speed is 430 revolutions per minute, and the feed 0.15 inch. The production time is five brackets per hour.

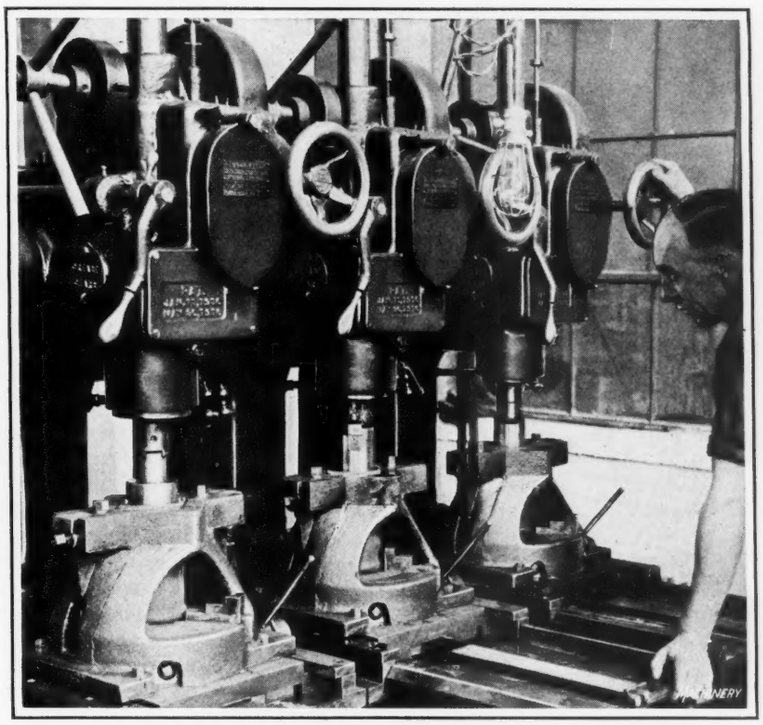


Fig. 5. Three-spindle Heavy-duty Drilling Machine with Track for moving the Jigs from Spindle to Spindle

Special Tooling for Multiple-spindle Drilling Machines

The three-spindle heavy-duty Colburn drilling machine illustrated in Fig. 8 is equipped with a special auxiliary table, which is fastened to the regular table and carries a parallel against which the jigs are guided as they are traversed from station to station. The jigs are provided with rollers for advancing them to the various spindle positions,

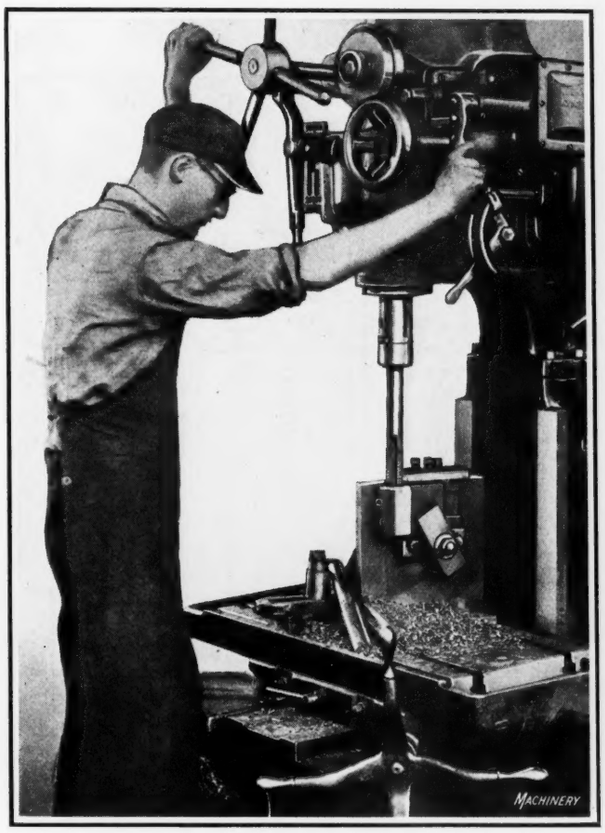


Fig. 6. Tapping Acme Threads by the Use of Three Taps

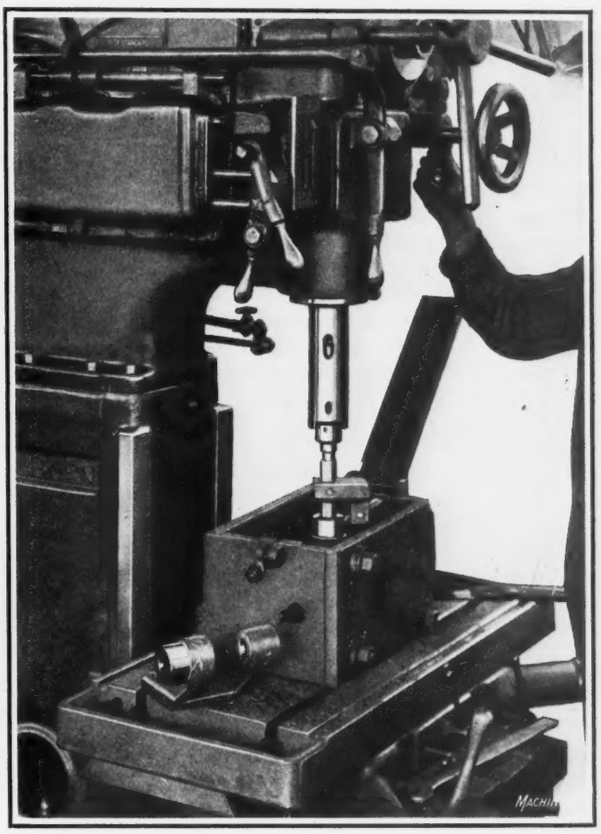


Fig. 7. Turning Hub of Cast-iron Bracket with Box-tool

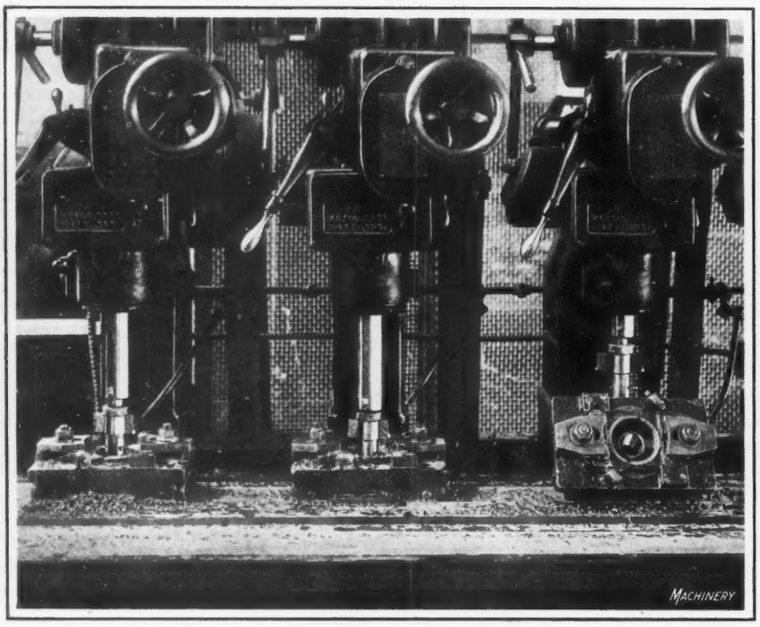


Fig. 8. Three-spindle Drilling Machine with Auxiliary Table and Tracks for sliding the Jigs from One Spindle to Another

as well as with rollers set at right angles to these, so that at the completion of the longitudinal travel of the jig it may be rolled forward on tracks running to the front of the table and at right angles to it, for convenience in loading. These tracks are not shown in the illustration. This method of moving the jig from one end of the table to the loading position at the opposite end makes it unnecessary for the operator to exert any manual effort, and also saves time.

The construction of the jigs will be understood by reference to Fig. 9, which is a plan view showing, by heavy broken outline, how the work is located in pairs, so as to form a complete circle. The work is located by V-blocks, and is clamped in this position by set-screws, being held down by large clamps *A*. The operations performed on this multiple-spindle drilling machine are rough- and finish-boring a 2.44-inch hole formed by two castings, as shown in Fig. 9, to limits of plus or minus 0.003 inch, and counterboring with a 2⅞-inch diameter tool to a depth of 1/16 inch. These steel castings are first disk-ground on the back surface to enable them to be properly seated in the boring jig. Four jigs are used for this work, the extra one being loaded while the operations are being performed on the first pieces. The spindle speed is 80 revolutions per minute and the rate of feed 0.006 inch per revolution. The production time is forty pairs or eighty machined castings per hour.

Drilling Spindle Sleeves

The spindle sleeves used in the construction of the Colburn heavy-duty drilling machine are drilled with the equipment illustrated in Fig. 10, which consists of a four-spindle No. 2 manufacturing type machine, on the table of which four jigs are mounted. The design of these jigs is shown in Fig. 11. The body *A* is mounted on trunnions which are carried in supports bolted to the face of the jig. The body is made of cast iron, and there are two serrated steel strips *B*, 120 degrees apart on the inside, which act as a cradle for holding the sleeves to be drilled; the work is secured in place by two set-screws, one at each end of the body.

There is a locating member *C*, which is assembled midway between the ends of the body, and on this member a flat milled on the side of the spindle sleeve rests, which takes the thrust during the drilling operation and also locates it centrally in the body of the jig. For loading and unloading, the body is swung into a horizontal plane, in which position latch *D* drops down and engages a slot in the end of one trunnion, as indicated by the dotted outline. The index-pin which locates the body in a vertical position during the drilling operation is operated by a small lever, which withdraws the pin against spring pressure and permits the body to be revolved. In Fig. 10 the operator is shown loading the first jig, from which the advantage gained by designing the jig to swing to a horizontal position is apparent. The drill bushings are knurled and slabbed, and are prevented from turning by a pin in each end of the body.

These spindles are made of 0.35 per cent carbon steel, and are 17¼ inches long with a 1 7/16-inch hole extending through them. In drilling this hole, the drills are fed half way through the sleeves, and the jig is then indexed through 180 degrees so that a hole may be drilled in the opposite end of the piece to meet the first one. It has been mentioned that a flat milled on the side of the sleeves is used to locate them in the jig. This flat is afterward milled off in finishing the outside of the sleeve, and rack teeth are cut on the exterior. When the space between the end of the bushing and the adjacent end of the work becomes filled with chips the bushing is lifted to allow the chips to escape, but there is no liability of inaccuracies resulting from this, because the body is held firmly and the drill is free from vibration. The production on this operation is one sleeve every 2½ minutes, that is, 24 per hour, floor to floor. This rate depends on the spindles being kept in continuous operation, and no time being lost in loading and unloading the jigs.

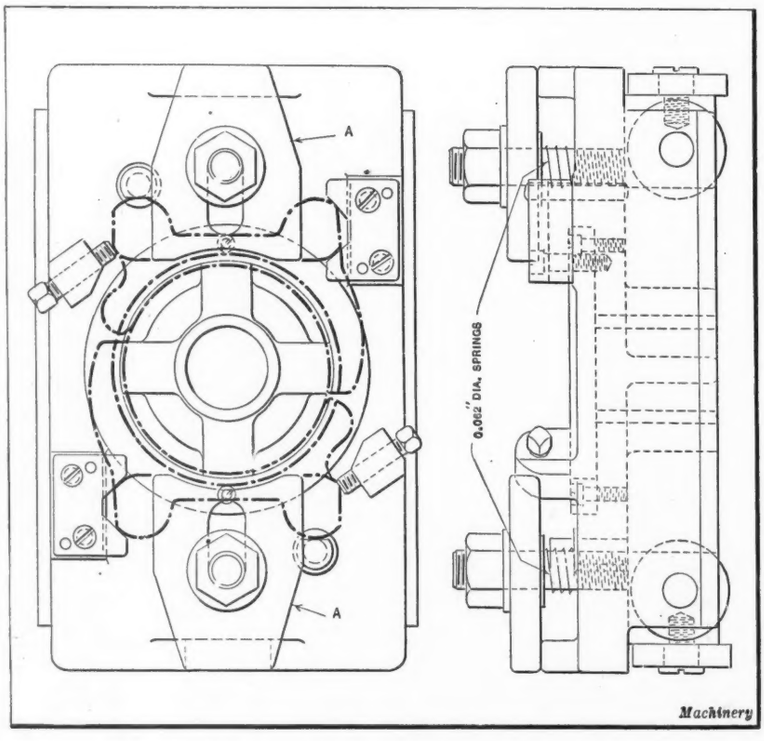


Fig. 9. Detail View of Jigs used in Operation illustrated in Fig. 8, showing how the Work is located

Drilling Bottle-filling Machine Gage Bodies

A cast-iron gage body for bottle-filling machines is illustrated in Fig. 12, in position on the Colburn heavy-duty drilling machine used in boring and reaming this piece. The jig used to hold the casting while machining the eight holes in each end is shown attached to the special base of the machine, which, in this case, is used as a table. This construction is employed when there is an unusual distance between the spindle nose and the locating surface. The jig is bolted to this special base, and is supported at the top by a bracket attached to the vertical ways on which the regular machine table is usually mounted. A combination boring and reaming bar is used in this operation, carrying two boring heads and two reamers and an extending pilot which enters the base of the jig.

The jig is of the indexing type, and two boring-bars are provided, one of which is in use while the other is placed in the next hole to be machined, so that as the work is revolved this boring-bar is brought into alignment with the spindle and connected with the quick-change collet chuck. The work is so long that if this were not done it would be necessary to rotate it to remove the boring-bar, then turn it again in order to permit the same bar to be passed through the holes, and finally turn it backward to bring it into alignment with the spindle of the machine. When indexing, a circular clamp at the top of the jig is loosened, a strap at the bottom is released, and the index-pin withdrawn by means of a cam-lever shown at the front of the jig.

The work seats on a cast-iron shoulder of the jig and is clamped down by a slotted washer at the top. A plug on the shoulder of the jig locates the gage centrally. The sixteen holes are 4⅝ inches in diameter and 5 inches deep, and the production time is thirty minutes per casting, as compared with 3 hours and 20 minutes by another method.

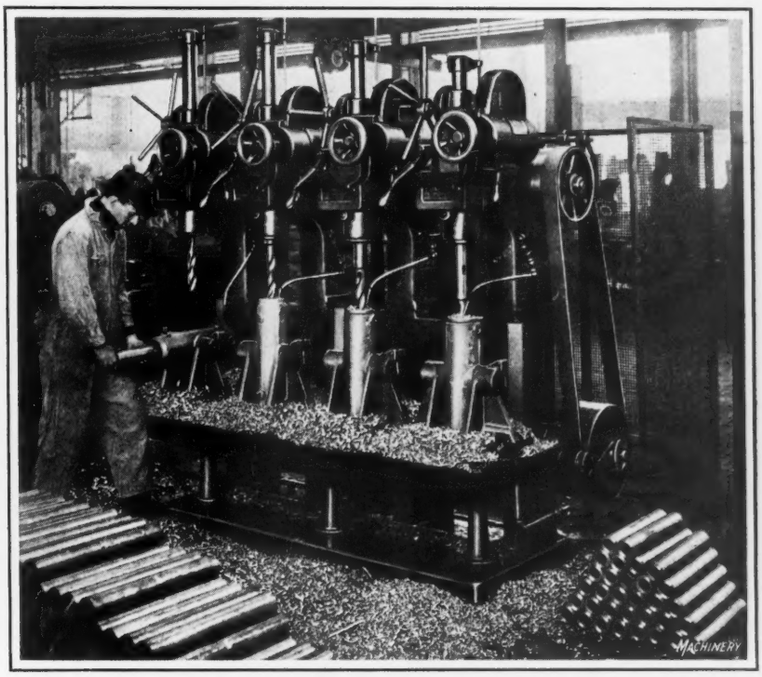


Fig. 10. Drilling Spindle Sleeve Holes 17¼ Inches Long by 1 7/16 Inches in Diameter

Boring Hole in Dredge Saddle

The boring of a saddle for a dredge is illustrated in Fig. 15. This is a steel casting the design of which is shown in Fig. 13. The machine used is a D-8 Colburn heavy-duty drilling machine, and the operation consists of rough- and finish-boring a 12-inch cored hole to 13 inches finished diameter. This hole is 10 inches long, and three cuts are required to complete the operation. For each of these cuts it takes fifteen minutes to feed the boring-bar through the work, so that the entire operation consumes 45 minutes. The rotative speed of the spindle is 23 revolutions per minute, and the feed is 0.030 inch per spindle revolution. While this is not a production job, it illustrates very well the capability of this type machine for handling work where heavy cuts in tough material are required.

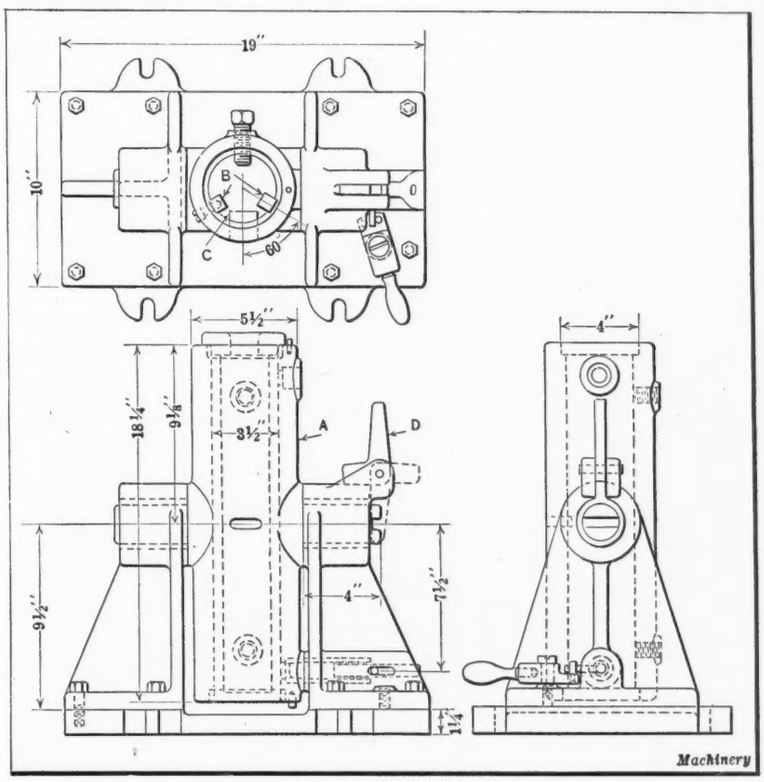


Fig. 11. Revolving Fixture in which the Spindle Sleeves are located while drilling

Handling Large-diameter Work

It often happens that work of large diameter, which would be exceedingly awkward to handle unless some special provision were made, may be machined by employing some such arrangement as is illustrated in Fig. 16. Here a No. 14 Colburn drilling head is mounted on a boring mill table in which a post is located around which the work may rotate during the drilling and reaming of the various holes in this casting. The work to be machined is a cast-iron can tester wheel which is used in testing cans by means of compressed air. A partial plan view and section of this wheel are shown in Fig. 14. There are forty-two 1¼-inch holes drilled and reamed on a circle of 31 inches radius, and the same number of 1-inch holes on a circle of 35 inches radius. All these holes are drilled and reamed with the set-up illustrated in Fig. 16.

The stationary post on the table, previously referred to, carries a slotted index-wheel at the top by means of which the work is indexed for drilling each hole. A radial arm is also carried on this vertical post under the index-wheel in which there are two bushings, one for the inner circle of holes and one for

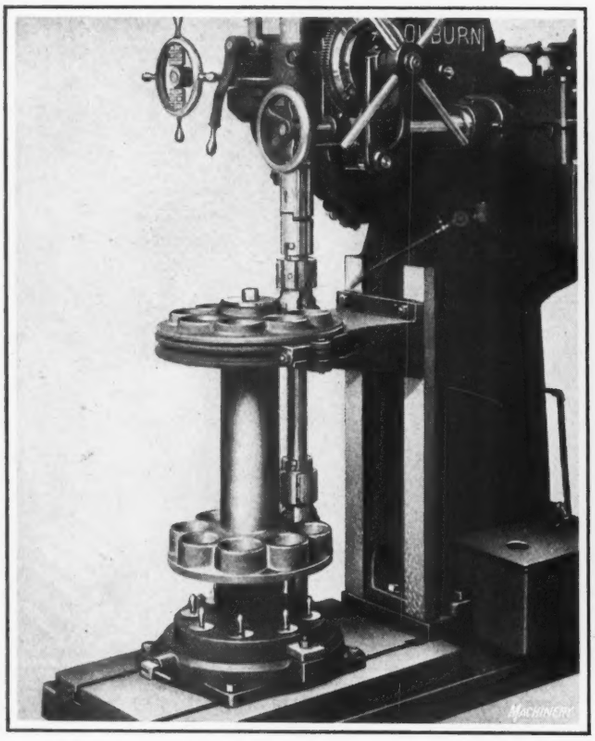


Fig. 12. Use of Extended Base and Indexing Jig for boring and reaming Long Work

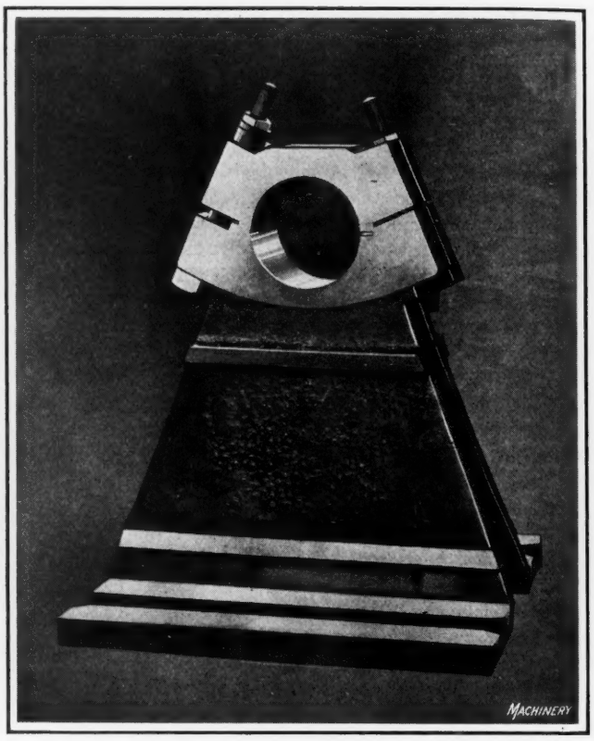


Fig. 13. Saddle for Dredge, showing Hole bored on Machine illustrated in Fig. 15

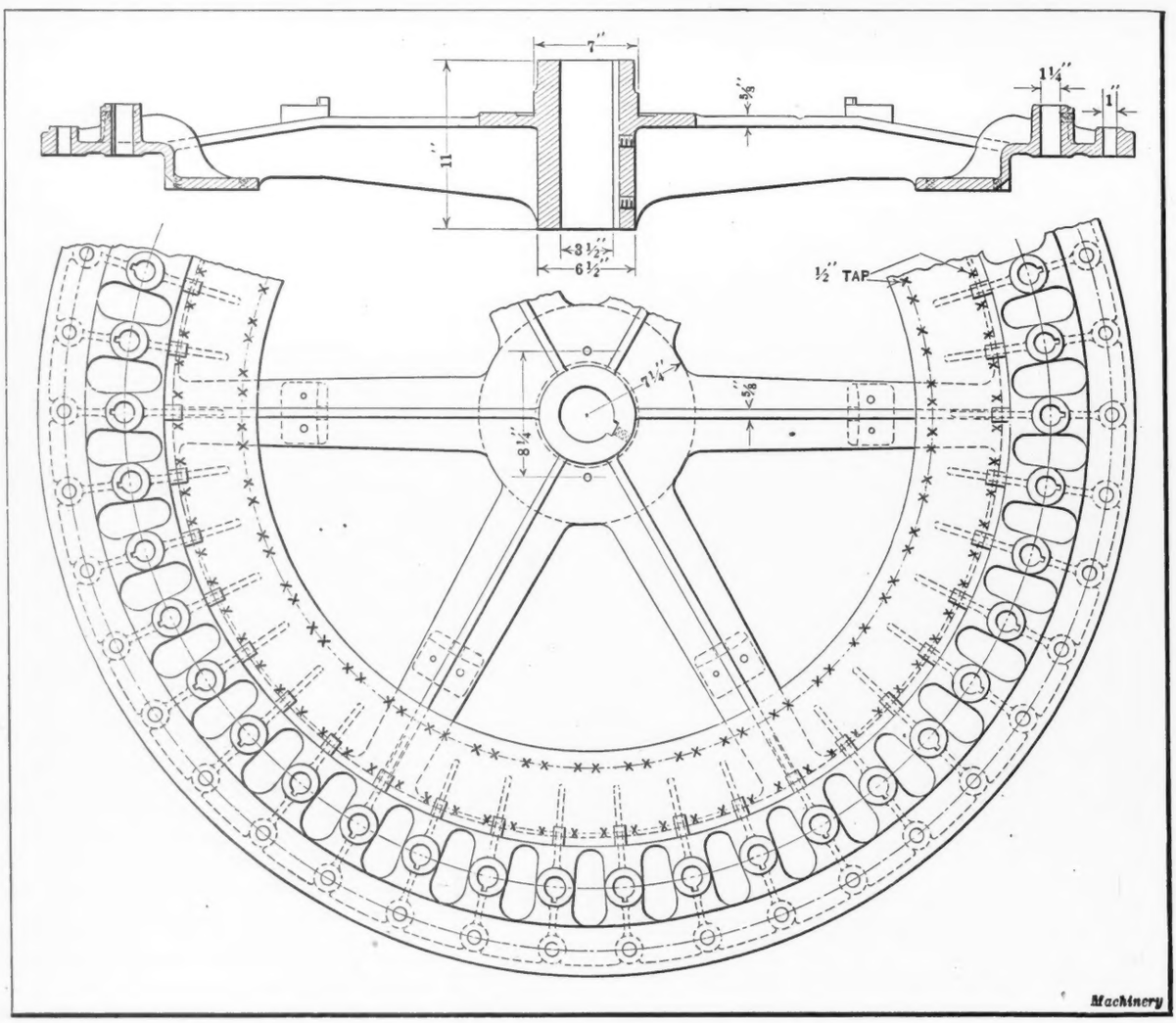


Fig. 14. Can Tester Wheel in which Eighty-four Holes are drilled with the Equipment illustrated in Fig. 16

the outer circle of holes. After the larger holes are drilled and reamed and the work has made two complete revolutions, the post is moved outward in the T-slot of the table in which it is clamped to obtain the correct radial distance for drilling the outer circle of holes. Then a plug is used in the larger bushing hole in the radial arm, and is passed down through one of the 1¼-inch holes so that the smaller holes are kept in radial alignment with these. A limit of 0.001 inch is allowed on the location.

The 1¼-inch holes are drilled and reamed through 3¼ inches of metal, using a drill speed of 160 revolutions per minute and a reamer speed of 45 revolutions per minute. The drill feed is 0.015 inch and the reamer feed 0.038 inch per spindle revolution. The 1-inch holes are drilled and reamed through 1¾ inches of metal, the drill speed being 300 revolutions per minute and the reamer speed 45 revolutions per minute. The feed used is 0.018 inch per spindle revolution for both drilling and reaming. The production is two wheels per eight-hour day.

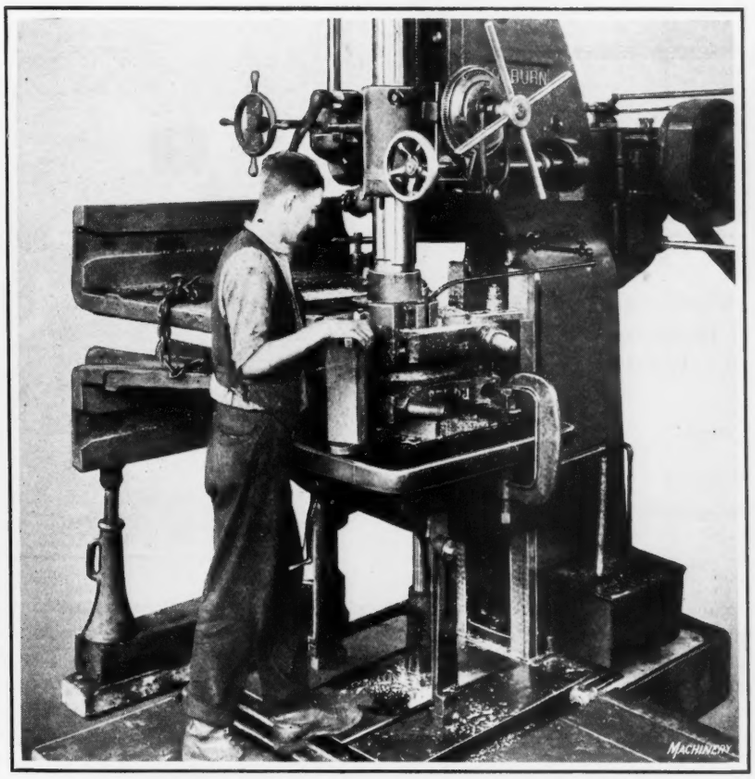


Fig. 15. Boring a 13-inch Hole in a Saddle for a Dredge

* * *

ANNUAL MEETING OF THE TAYLOR SOCIETY

At the annual meeting of the Taylor Society, held in the Engineering Societies Bldg., New York City, December 1 to 3, the program covered many problems of management. Some of the papers read are given in the following: "The Technique of the Appraisal of the Efficiency of an Industry" comprised a critical examination of the evaluation sheet devised and used by the engineers of the Committee on the Elimination of Waste in Industry. The discussion on this paper was opened by C. E. Knoeppel, C. E. Knoeppel & Co., New York City. A report of the Committee on Sales Engineering was made by Willard E. Freeland, Winchester Repeating Arms Co., New Haven, Conn. A paper on "Reflections of a Production Manager" was presented by Charles F. O'Connor, Universal Winding Co., Providence, R. I., and a paper on "The Necessity of the Quota for Proper Sales Cost Accounting" was presented by Charles P. Staubach, Burroughs Adding Machine Co., of Newark, N. J. Another paper "The Application of the Principles of Scientific Management to the Office" was read by William H. Leffingwell, Leffingwell-Ream Co., Chicago and New York, and a paper on "The General Control of a Business" was presented by John H. Williams, Day & Zimmermann, Philadelphia, Pa. The subject "Combination Routing" was brought up by D. J. Walsh, Jr., and a paper on "The Formula for an Efficient Workman" was presented by Boyd Fisher, Lockwood, Greene & Co., Boston, Mass.

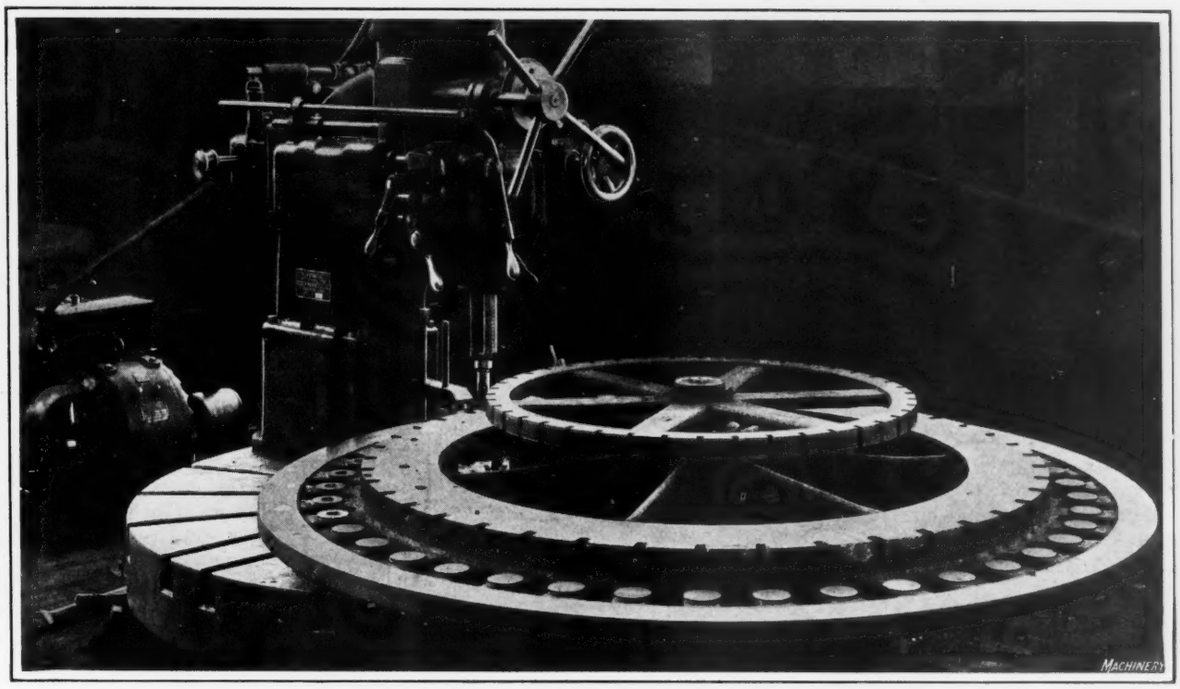
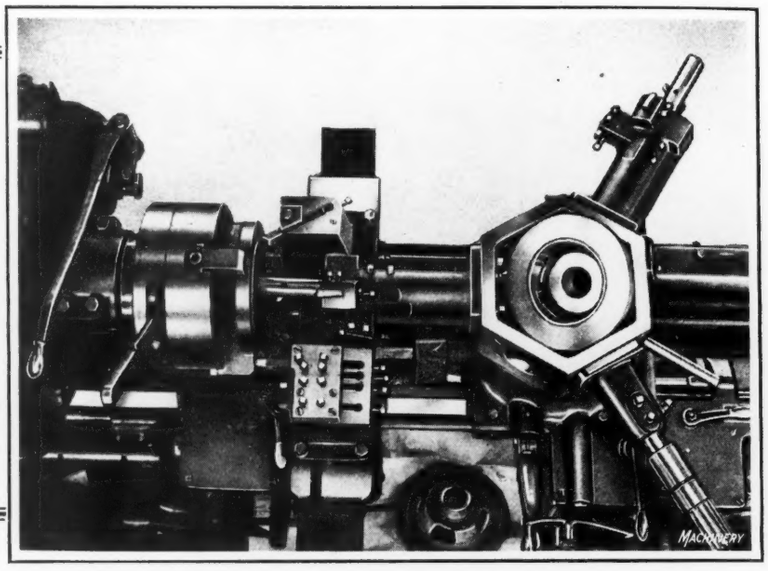


Fig. 16. Drilling Head mounted on a Boring Mill Table for handling Work of Large Diameter

Turret Lathe Tooling

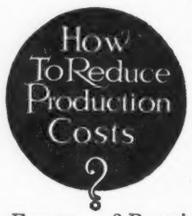
Equipment for Machining Differential Gear Housings on Foster Turret Lathes

By I. F. YEOMAN



THE illustrations accompanying this article show the tooling lay-out for machining a differential gear-case on a turret lathe. Before describing the various operations and equipment employed a brief review will be given of the way in which production problems for the Foster turret lathes are handled at the Foster Machine Co.'s plant in Elkhart, Ind.

When the blueprints are received from the customer, the head tooling engineer makes a study of them, and after ascertaining the surfaces to be machined and the limits required on these surfaces, notes on the blueprints the cutting speeds and the number of cuts required, together with the various feeds to be used in performing the machining operations. He also indicates the preferable method of holding the work in the chuck. The next step consists of making a rough sketch of the work to be machined, on which certain methods of finishing are indicated. For example, in Fig. 1 the details of both members of a differential housing are shown. It will be noted that the finished dimensions for the various surfaces to be machined are given; and also that the method of machining certain of these surfaces is indicated.



Sketches are then made showing the recommended type and location of the tools required in performing the operations for each chucking of the work, as well as the best method of chucking the part to be machined. If, as in the present case, two chuckings are required in finishing the work, one of these tooling lay-out sketches will be made for each operation. Figs. 2 and 3 show the general tooling arrangement provided for machining the differential gear housing, in the first and second chucking, respectively. After the preliminary sketches of the proposed tooling lay-out are completed, these and the engineer's suggestions regarding the machine to be used are submitted to the assistant tool designer who computes the floor-to-floor time estimate for each series of operations.

After the time study has been made, a copy of this and the lay-out made by the engineering department are sent to the prospective customer, who is given a complete explanation of the proposed method of machining the parts and is also advised regarding certain other details which have been observed in studying the job and in making the time study. As soon as an order has been received on the strength of the preliminary investigation, the design of the tools and all calculations pertaining to the machining of the work are carefully rechecked before the finished tool drawing is made. Blueprints of these drawings, accompanied by any necessary explanation, are then sent to the foreman of the special tool department, where the tools and designs are made.

Tooling for First Chucking on Differential Housing

All equipment used in machining the differential housing shown in Fig. 1, including chucks, expanding reamers, and special tool-holders are manufactured by the Foster Machine Co. and applied to a 2-B universal turret lathe of this company's manufacture. In the first chucking, it is considered advisable not to use the turret of the machine, a special arrangement being employed in its place, with the result that a substantial reduction is made in the cost and time required to machine the part. This arrangement consists of a multiple tool-holder, shown in Fig. 2, which is mounted on the cross-slide of the lathe in the position shown in Fig. 4, so that the tools may be brought successively into engagement with the various surfaces to be machined, by simply operating the cross-slide screw and feeding the carriage along the bed until it comes in contact with a positive stop.

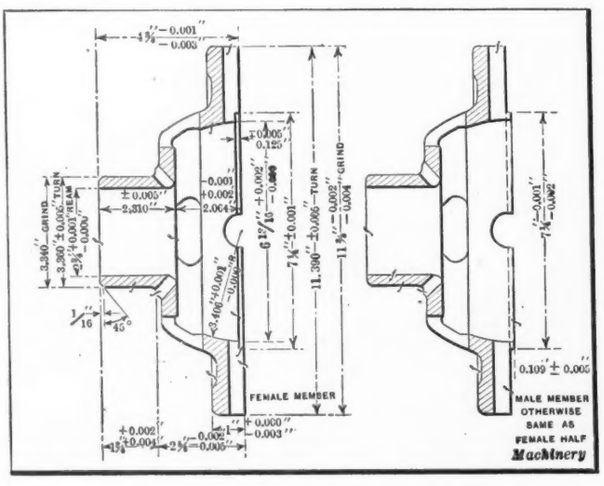


Fig. 1. Sketch giving Dimensions of Differential Gear Housings

In the first chucking, the housing is chucked on the inside, using a special 16-inch, three-jaw Barker wrenchless chuck, having corrugated and hardened steel jaws, carried in a heavy steel body. The first operation is that of rough-turning the outside diameters of the hub and flange. With the aid of the dial index of the cross-slide screw, the multiple tool-holder is traversed transversely to bring tools *B* and *C* into the proper position for turning the hub, which results in similarly positioning tool *E*, used in rough-turning the outside diameter of the flange. The cut required to machine the hub

is divided between the two tools *B* and *C*, so that the operation will be completed in the same time that the flange is rough-turned. Tool *C* also turns the fillet at the base of the hub and rough-faces the adjacent surface *C'*. All surfaces finished are indicated by the same reference letters used in designating the tools employed in machining. For example, tools *C*, *D*, and *E* are used in machining surfaces *C'*, *D'*, and *E'*.

Fig. 4 shows the tools near the completion of the rough-turning operation. The traverse of the carriage is automatically terminated by means of a positive stop as soon as the rough-turning cuts are completed. This brings the tools *A*, *C*, and *D*, Fig. 2, into the proper position for rough-facing the three surfaces similarly designated, during which operation the carriage is fed radially outward, as the feed diagram in the lower right-hand corner of the illustration indicates.

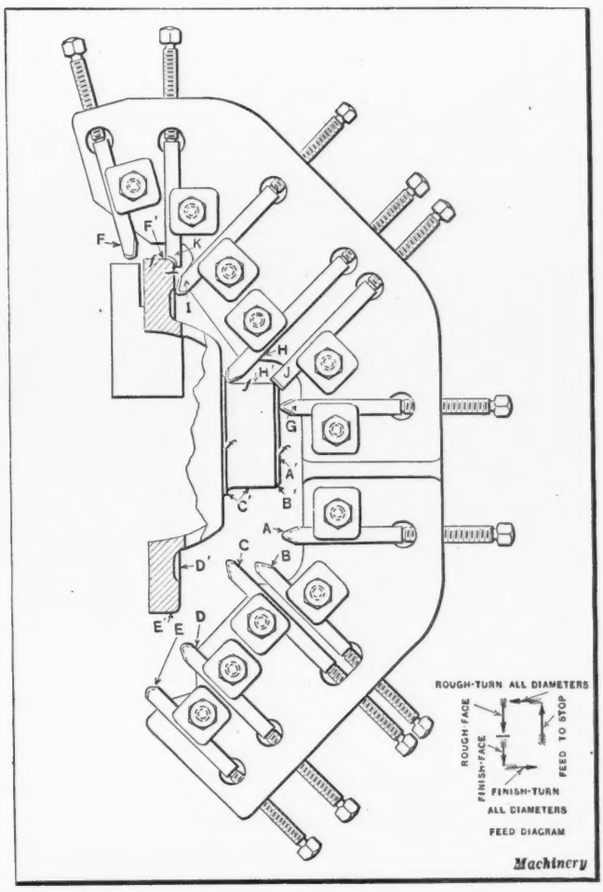


Fig. 2. Multiple Tool-holder which carries all the Tools used in the First Chucking

This completes the roughing operation, and the finish-facing cuts are immediately taken by continuing the cross-feed, which results in finish-facing the end of the hub with tool *G*, finish-facing the flange with tool *I*, finish-facing and forming the fillet at the base of the hub with tool *H*, as well as chamfering the end of the hub with tool *J* and forming a radius on the flange with tool *K*. This brings tools *F* and *H* to the proper position for finish-turning the outside diameter of the flange and the hub, respectively, and this is the position which the tool occupies in Fig. 2. In finish-turning these two surfaces, the carriage is simply fed longitudinally back to the starting position. This completes the operations performed in the first chucking, and the casting is then removed from the machine preparatory to performing the second series of operations. During the test made at the Foster plant, the floor-to-floor time for completing the first chucking on these malleable iron castings, was from 4½ to 5½ minutes.

Tooling for Second Chucking

In the second chucking, a combination of cutting tools is used in which both the turret and the cross-slide are employed. The casting is located in the three-jaw Barker wrenchless chuck, with the previously faced surface of the flange seating on three pins *A*, Fig. 3. The chuck, which holds the work by the periphery of the flange, is provided with special soft jaws, the gripping surfaces of which are corrugated as shown at *K*.

The surface *B'* surrounding the inner end of the hub and the corresponding outer surface of the casting are first rough-faced, the two facing operations being performed simultaneously. Tools *B*, *C*, *D*, and *E* are carried in a tool-block on the cross-slide so that after the tools have been properly adjusted by first positioning tool *B* for finishing the inner surface of the hub, the other tools will be in position for starting the facing cut on the flange.

The two tools *D* and *E* divide the cut, and so enable the flange to be rough-faced at the same time that surface *B'* is machined. The illustration shows the tools in the position that they occupy at the completion of this operation, at which time tool *C* produces the circular recess in the female member of the differential housing. (See Fig. 1). In machining the male member, it will of course be understood that the position of this tool will be such as to rough-face the annular projection corresponding to this recess. In these facing operations, the proper depth of cut is obtained by the use of a positive stop for the carriage, after which the surfaces are faced by feeding the cross-slide forward to a stop.

The hole in the hub is next rough-bored and the radius connecting the hole with the inner face of the hub formed, the tools being carried in the boring-bar mounted in the first side of the turret. This boring-bar also carries two radius-forming tools *F* for rough-forming the inner concave surface, and a tool *L* for taking a second cut in the female recess. The cutters *F* are located 180 degrees apart and are designed with chip clearance grooves as shown. When the male member is machined, tool *L* used in machining the female member is not, of course, required. The boring-bar mounted in the second side of the turret carries tools for finish-boring the hub, finish-facing surface *B'*, and for finish-forming the female recess and establishing the relation between the depth of this cut and the finished surface *B'*.

When machining the male member, the recessing cutter is set at the proper angle for finish-turning the outside diameter of the annular projection. It will be observed that cutter *G*, used in finish-facing the inner end of the hub, is different in design from

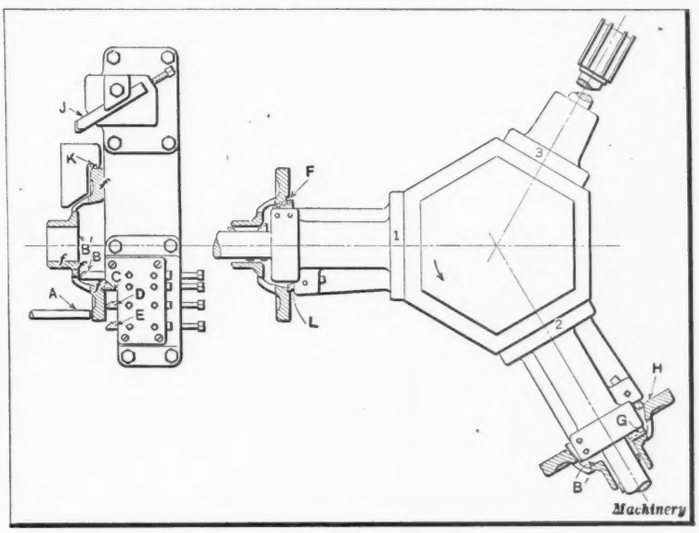


Fig. 3. Tooling Lay-out for the Second Chucking

tools used in other facing operations, owing to the fact that it must take a sweeping cut. During the finish-boring operation, tool *J*, carried in a tool-block at the rear of the cross-slide, is fed across the flange of the housing to finish-face that surface. In the heading illustration, this operation is shown near its completion, the tool *J*, Fig. 3, having not quite completed its cut. The final operation in machining the casting is that of reaming the hole in the hub, using an expanding reamer carried in the third side of the turret.

It will be noticed that in both tooling set-ups the tools are designed with provision for adjusting the cutters by the use of adjusting screws. The radius-turning cutters *F* are also designed so that they may be adjusted in various directions. The time required to complete the second chucking operations, during the test of tools conducted in the Foster shop, was 7¼ minutes per casting.

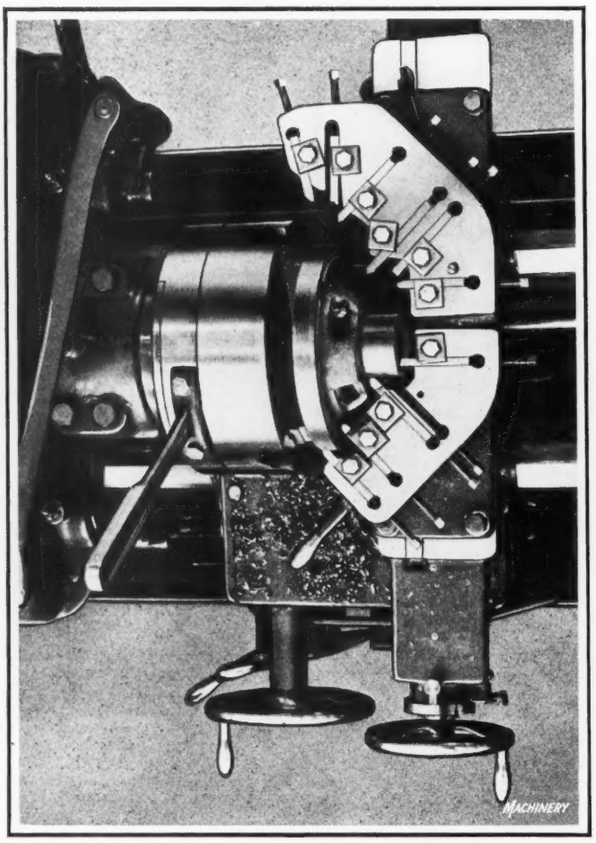


Fig. 4. Turret Lathe with Equipment used in the First Chucking Operation on the Differential Housing

It may be of interest to add, in connection with the description of the engineering service described in the opening paragraphs, that fifteen days after the receipt of the order for the tools described and illustrated in the foregoing, the equipment was thoroughly tested and delivered to the shipping department, ready for the customer's use. As the entire equipment was made in the plant of the Foster Machine Co., duplicate parts or tools can be supplied to the customer from the original drawings without delay.

* * *

TENSION IN BELTS

By N. G. NEAR

Some means of determining the tension in a belt while it is on pulleys is often desirable. The tension can, of course, be determined by means of a dynamometer, but as this method is a rather cumbersome one and takes considerable time, it is seldom used. When the belt drive is horizontal or nearly so, the writer has found it possible to determine the tension quite accurately by basing his calculations on the amount of sag in the belt. In employing this method, use is made of the following formula:

$$S = \frac{WL^2}{8T}$$

in which

S = sag, in feet;
W = weight of belt, in pounds per cubic inch;
L = span of belt, in feet;
T = tension in cross-section of belt, in pounds per square inch.

Applying this formula to leather belts, the writer computed the values given in the accompanying table, which will be found convenient for quickly determining belt tensions. To use the table, it is simply necessary to measure the span of the belt in feet, the distance between shaft centers, and the sag in inches, and then locate the columns in the table corresponding to these measurements. The tension can then be read directly in pounds per square inch. For example, if the span is 30 feet and the sag 5 inches, the tension will be 112 pounds per square inch. In some cases, it is possible to measure the sag, both on the tight and slack sides, while the belt is in motion. This cannot be done satisfactorily, however, unless the belt runs smoothly.

* * *

HOOVER CONFERS WITH TRADE JOURNAL EDITORS

The monthly conferences between Mr. Hoover and the editors of engineering and trade journals inaugurated shortly after Mr. Hoover became Secretary of the Department of Commerce are being continued, and the cooperation between the Department and the industries through the medium of the engineering and trade press is thereby facilitated to a marked degree. The problems of the industries may be transmitted to Mr. Hoover in this manner, and he, in turn, has a channel to which he can easily turn for information on any subject relating to the whole industrial field. The close cooperation with the industries that Mr. Hoover is endeavoring to establish is probably the greatest step ever taken in making the Department of Commerce of real value to commerce, trade, and manufacturing interests. The greatest help the industries can render is to make definite suggestions as to the assistance the Department can give.

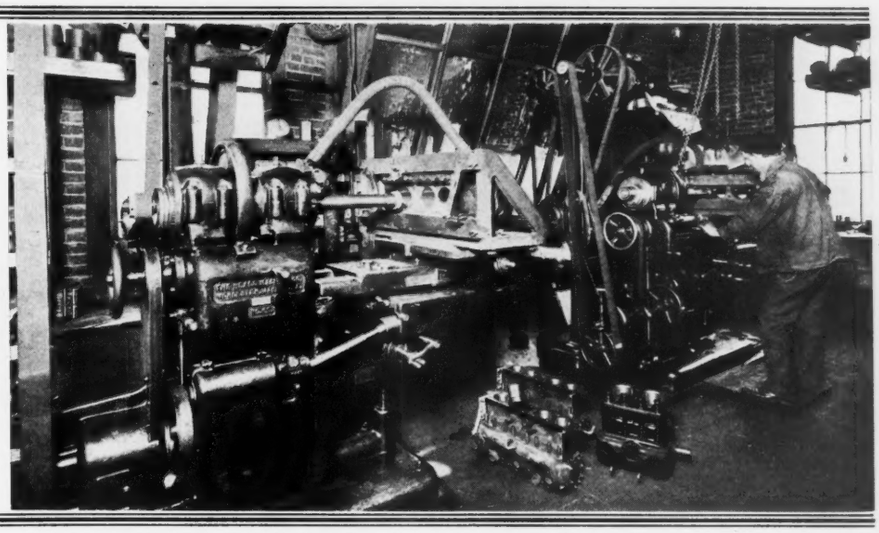
TENSION OF BELT IN POUNDS PER SQUARE INCH

Distance between Shaft Centers in Feet	Sag of Belt in Inches											
	1	2	3	4	5	6	7	8	9	10	11	12
5	16.5	8	5.3	4	3.2	2.7	2.3	2	1.8	1.6	1.5	1.3
10	64	32	21	16	12	10	9	8	7	6.4	5.5	5
15	140	70	46	35	28	24	21	18	15	14	13	12
20	250	125	82	62	50	42	36	32	28	25	23	22
25	380	190	130	100	80	66	57	50	44	38	35	33
30	560	280	180	140	112	94	82	72	64	56	52	48
35	780	390	250	190	150	130	110	97	86	78	70	64
40	1000	500	320	240	200	170	145	125	113	100	92	85
45	1280	640	400	300	250	210	180	157	142	128	117	107
50	1580	790	530	400	300	250	225	195	175	158	145	131

Machinery

Automobile Repair Shop Practice

First of Three Articles Describing Methods and Equipment Commonly Employed in Automobile Repair Shop Practice



THE greater part of automobile engine overhauling is confined to cylinder work; this includes, besides the resizing of the bores, refitting of pistons, rings, and wrist-pins, and aligning connecting-rods. When the pistons are loose, an automobile engine wastes power, due to the pumping of oil and the reduced compression. These troubles can be eliminated quickly and without much expense by regrinding and refitting, and this fact, coupled with the growing need for repair work of this general type, has led to the establishment throughout the country of repair shops for handling engine work exclusively.

Some shops do not have the equipment for handling parts other than cylinders, pistons, and rings, while others are fully equipped for repairing crankshaft bearings by welding or by grinding down the crankpin and main bearings; reseating cylinder valves; straightening, rebushing, and fitting connecting-rods.

The methods followed in different repair shops vary somewhat, although the results obtained are essentially the same. It may be that the practice in one locality would not be practical in another place due to the local demands, which of course would also affect the equipment used. In this series of articles the procedure followed in a number of repair shops for performing work of like nature is described.

Common Engine Troubles

When an engine is dismantled, it is often found that there is an excessive clearance between the piston and the cylinder. The piston-rings often have large black spots on their outer periphery indicating that the rings have not been bearing on the cylinder wall, and through the space thus left the expanding gas has been escaping, resulting in a loss of compression and efficiency of the engine. It is sometimes found that the cylinders and pistons are rough or scored, due to insufficient lubrication, so that it is impossible for the rings to prevent the escape of gas.

It may be that a wrist-pin is discovered to have worked loose and to have cut a groove in the cylinder wall, a condition which will also allow gas to escape. Even though the cylinder wall is perfectly smooth, it may be found upon investigation, that the part of the cylinder in which the rings travel has been worn larger, permitting the rings to expand and the gas to escape at the joint. If the cylinders are worn to this extent, the gas also usually escapes around the circumference of the ring even more than at the joint. The cylinder bore may be worn oval-shaped and be from 0.005 to 0.010 inch greater across one axis than the other and, of course, no ring can be made that will conform to such a condition. The wear in the region of the ring travel, which is only about half the length of the cylinder, is commonly encountered, but this can be readily remedied by regrinding.

Another phase of general automobile engine repairs has to do with the crankshaft. When the crankshaft has sprung out of alignment and when its journals are worn out of round, the result is excessive vibration, noise, and an unbalanced and uneven running engine. In overhauling an automobile engine, special attention should always be given to the crankshaft. If the crankshaft bearings need regrinding, this should not be neglected, as the cost of doing this work at the time when the engine is being overhauled is small. If this is not done and an attempt is made later to fit a set of bearings to a shaft which is not perfectly true, much more time will be consumed and a far less satisfactory result obtained. The practice of filing, lapping, and polishing a crankshaft is practically obsolete, as it is not only slow but almost impossible to obtain accurate results.

Cylinder Regrinding

If an engine has been dismantled and it is found that the cylinder bores are in need of resizing, a series of operations is necessary in order to put the piston back into proper running condition. First, each cylinder bore in the block must be accurately reground to the same diameter until all marks are removed, which sometimes necessitates the enlarging of the bores an average of 0.015 inch on the diameter. If the bores are deeply scored, it is often better practice to weld the worst places and then grind to size. New pistons must then be fitted to these ground cylinders, and for this purpose it is necessary either to keep a supply of rough or partly machined over-size pistons on hand or, if the establishment is large enough and the practice of finishing replacements from rough castings followed, a full line of patterns is required.

Over-size pistons may be procured commercially to meet almost any condition. They must then be machined to fit the cylinder bore; the outside diameter is usually finished by grinding, although in some cases the pistons are finish-turned. The pistons must be fitted with over-size rings, and these may be bought in sizes varying by certain increments, such as 0.005 inch on the diameter. The variation in diameter of the piston-rings has an effect upon the practice followed in regrinding the cylinder bores; for example, if the

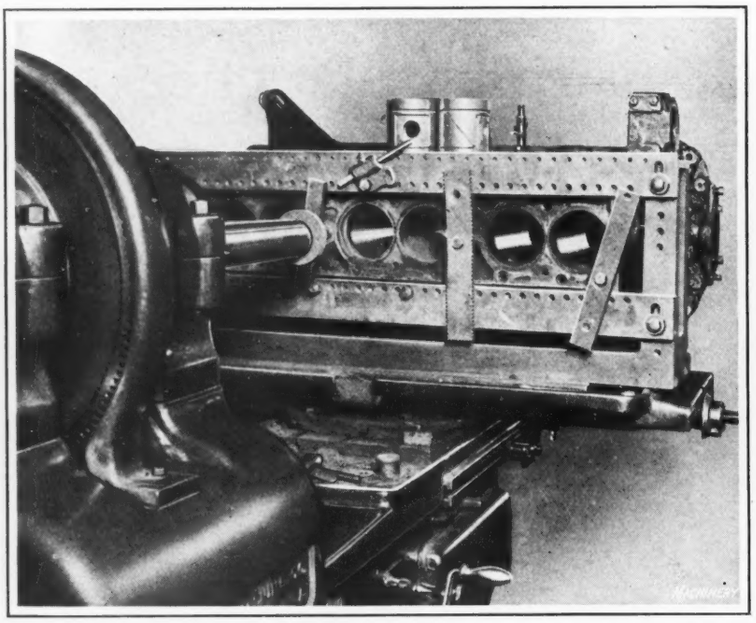


Fig. 1. Cylinder Grinder set up for regrinding the Bores of a Six-cylinder Marmon Sleeve-valve Engine

diameters are increased by increments of 0.005 inch (even although more metal may be removed than is absolutely necessary to clean up), the finished pistons may be fitted without any additional machining.

If it has been found, in disassembling the connecting-rod, that the wrist-pin is badly worn, it is, of course, necessary to furnish a new set of wrist-pins and in some cases, perhaps, provide new bushings in the connecting-rods. Wrist-pins may also be purchased to meet almost any desired condition. After the connecting-rod and piston have been properly fitted, the assembly should be tested for alignment and straightened so that the cylindrical surface of the piston will be at right angles to the crankpin bearing of the connecting-rod. An auxiliary repairing operation is regrinding the seats on the exhaust and intake valves, and this should not be neglected. This can be done with a special bench type of equipment to which reference will be made later.

Regrinding the Bore of a Sleeve-valve Engine

At the plant of Frostholm Bros., Syracuse, N. Y., all classes of automobile engine repair work are done. Fig. 1 shows a No. 55 Heald cylinder grinding machine on the table of which a Marmon sleeve-valve aluminum cylinder block is mounted. The cylinder regrinding work on a sleeve-type aluminum engine is the same as on a cast-iron block except that the factor of overheating must be taken into consideration. The block is attached to a regular angle-plate type of cylinder fixture similar to that furnished by the manufacturers of this grinder. This is a six-cylinder block, having a bore 3¾ inches in diameter, and it is ground with a No. 303S carborundum wheel. It is generally practicable in cylinder regrinding to take at least two cuts. For roughing, about 0.005 inch of metal is removed per table travel, and for finishing about 0.0015 inch, both these figures varying according to the judgment of the operator. This block is to be fitted with "Kant-Skore" aluminum alloy pistons, two of which are shown on top of the fixture.

In this fixture two steel parallels are bolted to the vertical side of the angle-plate, in which a number of holes are drilled. This enables the block to be bolted in place readily and also permits cylinders of any size or type to be mounted on the same fixture. It is recommended that the wheel be trued up before starting the finishing operation, and for convenience in doing this a diamond wheel-dresser is attached to the upper parallel of the fixture. The dust is removed from the cylinder by an exhaust fan to which a flexible tube is attached, with the open end resting in the outer end of the cylinder bore.

Regrinding an Overland Cylinder

The operation illustrated in Fig. 2 is that of regrinding an Overland four-en-bloc cast-iron cylinder, having a 4⅛-inch bore. This work is also done on a No. 55 Heald type machine equipped with a cast-iron angle fixture of similar design to that previously referred to. This machine is in use at the plant of the Nixon Tool & Broach Co., Syracuse, N. Y. This illustration shows the method of mounting the cylinder more clearly than Fig. 1. Four universal plates are provided for clamping the work to the fixture, two of which are carried at opposite ends of each parallel. These may be assembled in any of the holes in the parallel and may be tipped at any angle to suit the holes in the cylinder block. In this case, the lower left-hand plate was tipped so the bolt at this corner would reach through the hole in the plate.

The lower parallel has a T-slot in which the bracket which carries the wheel-dresser slides. In mounting the cylinder in the fixture, it is necessary to use an indicator at each corner in order to make the block perfectly horizontal. In setting up the job, the operator locates each bore centrally, relative to the grinding wheel, by setting the spindle eccentric, successively, at 90-degree positions by hand, until the trial spark produced at each quarter appears to be about the same. The experienced grinder can detect very accurately any variations in central position by either watching the spark or by the sound, although watching the spark is the more reliable way. While this work is being done the eccentric is not revolved, except as it is turned by hand, and the spindle is driven by power in the regular way.

Method of Setting and Adjusting Wheel Positions

The cylinder which appears to be the most deeply scored is first cleaned up and the other bores ground to this diam-

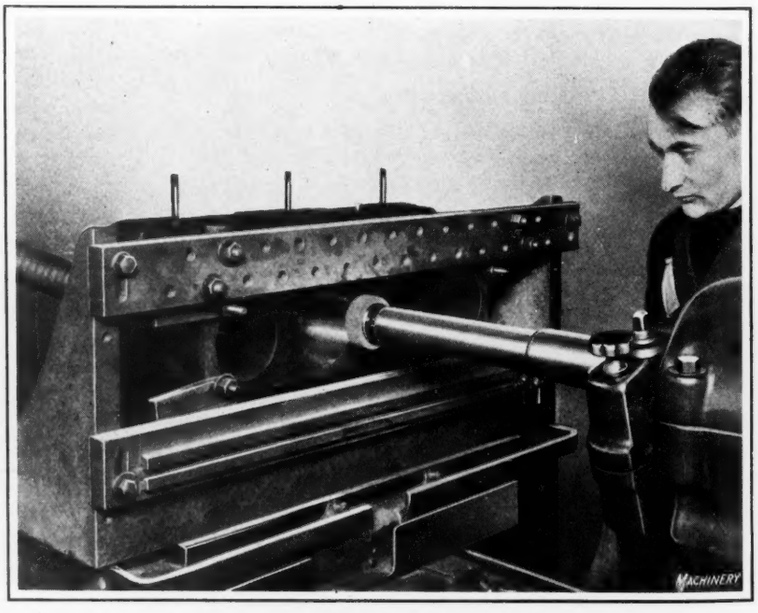


Fig. 2. Regrinding an Overland Four-en-bloc Cast-iron Cylinder

eter. For average work it is necessary to increase the cylinder bores about 0.020 inch, according to the experience of the Nixon Tool & Broach Co., and it has been noticed that rarely is it required to remove more than 1/32 inch from the diameter. A No. 36-H Norton wheel is used and about 0.005 inch of metal is removed in the first operation. If it is found that this does not clean up the bore, another 0.005 inch of metal is removed in the second travel of the table, and so on by increments of 0.005 until the cylinder is free from any score marks. This method is necessary in this plant on account of the practice of using over-size piston-rings varying by 0.005 inch.

After the first hole has been ground to the required size, the graduated dial for the radial feed of the wheel is set at zero, and the eccentric turned back so as to move the wheel in from the ground surface. This will enable the wheel to enter the second cylinder bore before starting this operation; in setting up, the same procedure of hand adjustment and observation of the spark, previously described, is followed. A 24-inch diameter exhaust fan is used to remove the cast-iron dust from the cylinder bore. The time required to grind a four-en-bloc cylinder of this size bore averages about 3½ hours.

Regrinding Large-bore Stationary Engine Cylinder

The cylinder regrinding operation illustrated in Fig. 3 is performed in the plant of Frostholm Bros. and consists of resizing a stationary engine cylinder, 8 inches in diameter, having a 20-inch stroke, on a Brown & Sharpe No. 23 cylinder grinder. This machine has a special tapered spindle, which is designed to eliminate wheel chatter. The general practice of this company is to use a No. 303S carborundum wheel for soft cast iron, and a 36-J Norton wheel on hard cast iron or semi-steel. On the job illustrated a No. 303S carborundum wheel is used. For the roughing cuts, from 0.002 to 0.003 inch of stock is removed on the diameter, but for finishing, the depth of cut is not over 0.0005 inch.

This regrinding job is an example of large work, which is very near the maximum limit. A 6-inch diameter wheel is used, running at 500 revolutions per minute, and it requires about fifty travels of the table to regrind the bore to the proper condition and with the degree of accuracy required. In the course of these fifty travels of the table, the diameter of the cylinder is increased about 1/32 inch. The diameter is tested by means of a special block with beveled edges, on which an Ames indicator is attached, and this test-block is slipped into the bore; the bearings of the two beveled edges of the block and the indicator point furnish a ready means for inspecting the parallelism and uniformity of diameter of the hole.

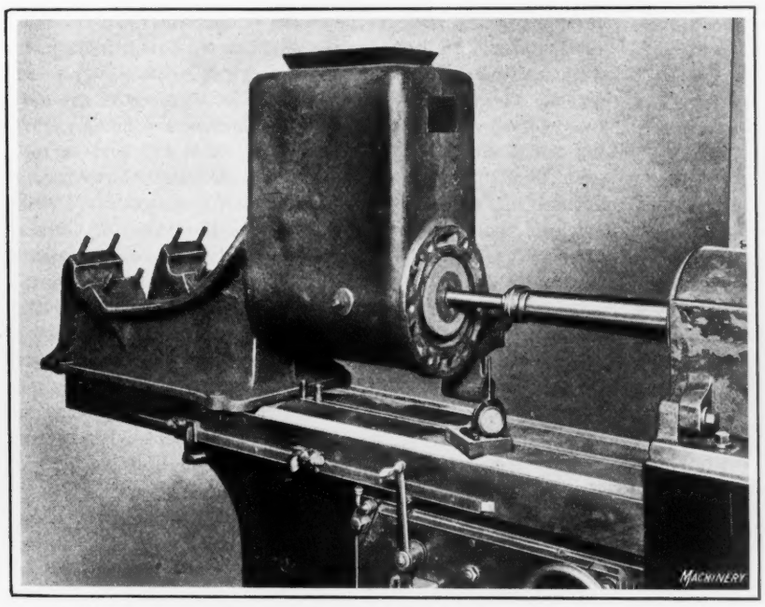


Fig. 3. Stationary Engine Cylinder set up for regrinding the Bore

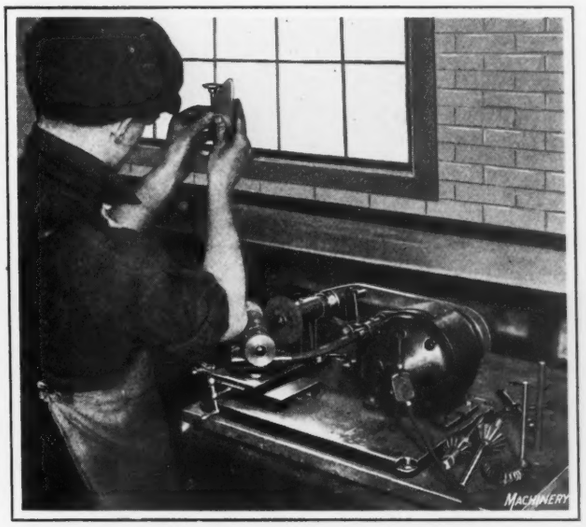


Fig. 4. Grinding Valve Heads to reseat in Exhaust and Intake Ports

Variations in Regrinding Practice on Cylinder Work

In the repair shop of Saucke Bros., Rochester, N. Y., Heald No. 60 cylinder grinding machines and the regular equipment are used, two of which are shown in the heading illustration. The block shown mounted on the first machine is a four-cylinder block taken from a Republic truck, the bore being 4⅛ inches in diameter and 10½ inches long. On the table of the other machine is mounted a six-cylinder Hudson block, 9½ inches long, with 3½-inch bore. In this shop it is the practice to first measure the blocks and determine which of the cylinders is scored the deepest. The bore that is scored deepest is ground first and all others are then ground to the same diameter. The most severely scored cylinder encountered in this shop required the removal of 1/16 inch on the diameter. Both the 303S and 30R carborundum wheels are regularly used for cylinder regrinding work in this shop, and the practice in the actual operation of the machine is to remove about 0.001 inch per traverse of the table until within about 0.002 inch of the finished diameter size. The wheel is then squared up and 0.0005 inch removed per cut until the finished diameter is obtained.

For the roughing operation the highest table feed is used, and for finishing, the lowest table feed. The work-head feed usually employed is the second feed provided on the machine. The recommended wheel speed is from 6100 to 6700 revolutions per minute for a 3-inch diameter wheel, which is equivalent to a surface speed of from 4825 to 5050 feet per minute. The approximate adjustment of the table crosswise when locating the work for successive cylinder bores is obtained by adjustable dogs, and the finer adjustments by the micrometer dial on the cross-feed screw. In actual practice, however, it has been observed that the operator depends more upon his observation of the spark than upon any mechanical means for obtaining the table location when aligning the cylinder bore with the machine spindle.

Grinding Valve Stems

In grinding valve stems in the Frostholm Bros. plant, a Franklin Machine & Tool Co.'s grinding equipment is employed. This equip-

ment is illustrated in Fig. 4 in which the operator is shown using the gage for testing the angularity of the seat relative to the stem. The gage has a semicircular groove in which the valve stem fits while the angularity is being gaged. A 46K Norton wheel is used with this motor-driven bench grinder, and the stem is chucked in a special draw-in collet chuck. The cutters shown on the bench are also ground with this equipment; they are mounted on an arbor and held in the draw-in collet chuck similarly to the valve stem. These tools are used for remachining the seats for these valves in the cylinder blocks.

Coming installments in this series of articles will deal with the practice of machining pistons and crankshaft repair work.

* * *

INDUSTRIAL STANDARDIZATION IN GERMANY

Standardization is playing an important part in Germany's industrial reconstruction. The German industries are carry ing out a far-reaching program of standardization as a necessary step in building up the industrial structure necessary to reduce production costs in order to gain extensive foreign trade. In no other country, except in Great Britain, is standardization work carried on upon a larger scale than in Germany. American industrial leaders must sooner or later take note of this standardization work, because our ability to compete in foreign markets with German goods will depend largely upon the manner in which we are able to produce standardized goods cheaply.

Scope of Standardization Work

Prior to 1917, a great deal of standardization work was done in Germany by individual companies, engineering societies, and industrial associations; but the work was not unified along national lines. Noting, however, the success of Great Britain, which organized its national standardization body in 1901, Germany formed a central standardization bureau in 1917, the membership of which consists of engineering societies, industrial organizations, government departments, and 700 leading industrial firms. In the four years since its formation, 144 approved data sheets of standards have been issued, and over 500 additional standard sheets of data have been so far developed that they have been published in tentative form. These standards are issued under the general designation of "German Industrial Standards." The data sheets are published in loose-leaf form, and generally so arranged as to make each sheet independent of the remainder. These sheets are bought by interested firms in any required quantity, and issued directly to their designers, draftsmen, and foremen. This plan is now also followed by the Austrian, Dutch, Swedish, and Swiss standardization bodies. The sale of the German data sheets of standards is said to amount to over 1,000,000 a year.

The standardization bureau has an extensive information service on standardization work in Germany and other countries which is available to the industries. A similar information service has been started by the American Engineering Standards Committee. In this connection it should be noted that the German and Japanese industries appear to study foreign developments much more closely than do the industrial leaders and engineers of other countries.

Methods of Standardization

The standardization work done on the continent of Europe in engineering, looked at broadly, indicates that these countries are going much further into dimensional standardization than has been done in England and America. The object is to secure interchangeability of supplies and machine elements, so that parts of similar apparatus made by different makers may be used without difficulty for similar service. By far the greater part of the German standardization work has been devoted to machine parts, screw-threads, bolts and nuts, standard diameters, systems of limit gaging, etc.—in other words, to purely engineering matters. The Anglo-Saxon mind takes more interest in matters having to do with purchases and contracts, such as specifications for materials and for the performance of apparatus, methods of tests, etc. The German bureau has as yet done very little of this kind of work, although it has been highly developed by some of the German industrial associations, as for example, in the electrical industry. Greater dependence is placed in continental Europe upon theoretical and basic engineering considerations, while the Anglo-Saxon standardization is guided by expediency in adjusting commercial considerations.

Comparison between American, British and German Standardization Work

According to a statement published by the American Engineering Standards Committee, German manufacturers will go much farther in yielding apparent temporary commercial advantages for the sake of advancing their national industry as a whole than American or British manufacturers. This is doubtless due to one of the fundamental German traits, that of planning definitely for the future—often for a future far ahead—while the Anglo-Saxon prefers rather to take the step that seems most expedient at the time, sometimes without very careful consideration of the effects of that step in the long run.

It appears that the work done in Germany is woven very intimately into the industrial fabric. In the work of standardization, the central organization has 5000 firms as cooperating members. There seems to be a striking analogy in the present standardization there and the research work of a generation ago. Whatever estimate one may place on the role played by German industry in general, everyone agrees that research was fundamental to the marked success of the German chemical industries. Apparently the Germans are expecting standardization to prove equally important in their general industrial development.

A complete copy of the report on industrial standardization in Germany, prepared for the American Engineering Standards Committee by its secretary, will be sent to anyone interested upon application to the committee, 29 W. 39th St., New York City.

* * *

REPORT ON AMERICAN MACHINE TOOLS IN GREAT BRITAIN

According to a special report recently received by firms in this country who are members of the American Chamber of Commerce in London, the market in Great Britain for American machine tools, once a very good one, now scarcely exists. The factors responsible for this depression are carefully gone into, and interesting comments are made regarding the likelihood of a decreased market for American tools even when trading conditions shall once more have become normal. The report also reviews the state of the British machine tool industry, and discusses the effect of German competition both in Great Britain and in Europe. Hints as to marketing American machine tools are given, and manufacturers in the United States who are considering the British market are advised to consult the American Chamber of Commerce in London, which is always ready to give the benefit of its experience in these matters. Full details are available only in the report which has been sent to members, but concerns interested can obtain copies by writing to the American Chamber of Commerce in London.

* * *

The Latvian Government has adopted a law effective for a period of five years (until April 1, 1926) whereby all industrial machinery and equipment intended for the reconstruction of Latvian industries or the establishment of new industries will be admitted into the country free of duty.

Reclaimed Leather Belting

Use of Salvaged Leather Belts Reinforced with Woven Cotton Fabric

OLD, stretched-out, oil-soaked leather belting can be freed from grease and dirt, and, with proper treatment, can be reclaimed for efficient service. This salvage work is being done commercially with satisfactory results. At an expenditure of 50 per cent of the original cost of leather belting, the life of a belt may be almost doubled without impairing its efficiency. The Syracuse Belting Co., of Syracuse, N. Y., manufacturer of reclaimed belting under the trade name of "Nu-Bilt," uses a process of reclaiming that is quite simple. The secret of the method lies in providing a suitable fabric as a backing to reinforce the scrap leather; the backing must be such that it will not produce an unequal amount of stretch between the leather and the reinforcing material. Solid woven cotton belting is the material used by this company as a backing. It is furnished by the manufacturers in coils of 500 feet, and is then stretched over rolls and held in tension while it is being coated on the side that is to be cemented to the leather with a specially prepared sizing cement. This is allowed to dry thoroughly and set the stretch before being removed from the rolls. It is then free from any further appreciable elongation.

In the process of reclaiming oil-soaked and discarded leather belts, the oil and the grease are extracted previous to applying the fabric backing of woven cotton belting. In treating ply belting, the original plies are separated and each thickness used separately, so that double or triple the amount of reclaimed belting is obtained. The old belting is cleaned in a bath of naphtha in which it is thoroughly soaked. It is then removed from the bath, artificially dried, and passed between rolls to squeeze out the grease that is not removed by the naphtha bath. The leather is next sized for uniform thickness on a leather belt machine, using a knife for scraping off the uneven surface. The belt is afterward hand-scraped to remove any dirt that might not have been scraped by the machine.

The edges are then squared up, or when making narrow belting from wide belting, cut into strips by drawing the belting over a knife. The winding and measuring machine in which this work is done has a straightedge for guiding the leather and producing strips having parallel straight sides. This is of the utmost advantage when making wide belts from narrow ones, which is commonly done by simply building out the width by laying the narrow pieces side by side on fabric backing of the desired width. Sections as short as one foot may be used to piece out a belt. After being treated, the leather is coated with high-grade cement, applied to the flesh side, against which the stretched and sized woven belting is laid while both are run through a press. After the cement between the fabric and the leather has thoroughly set, the edges must be finished to remove all unevennesses. This operation is similar to the edging of old leather, using a winding and measuring machine.

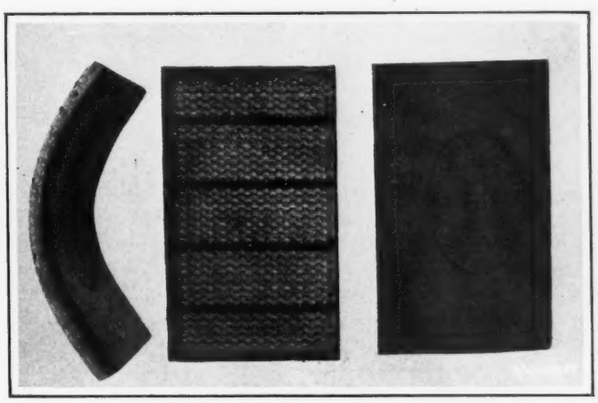


Fig. 1. Reclaimed Belting showing Face and Edge

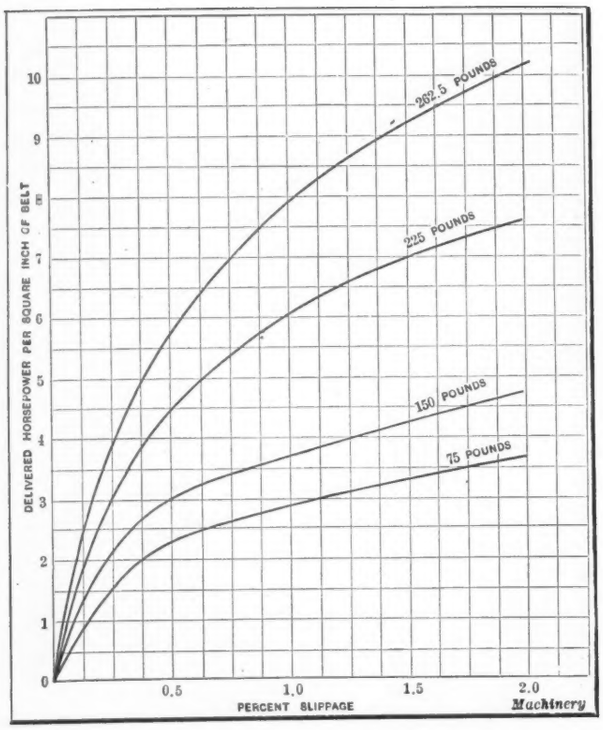


Fig. 2. Chart showing Horsepower of Reclaimed Leather Belting running at a Speed of 1000 Feet per Minute and having Different Initial Tensions

Efficiency in Power Transmissions

It will be realized that the finished product is practically free from further stretch, so relacing to take up slack is not often necessary. Some sections of reclaimed belts are shown in Fig. 1. The reclaimed belting is very pliable, enabling

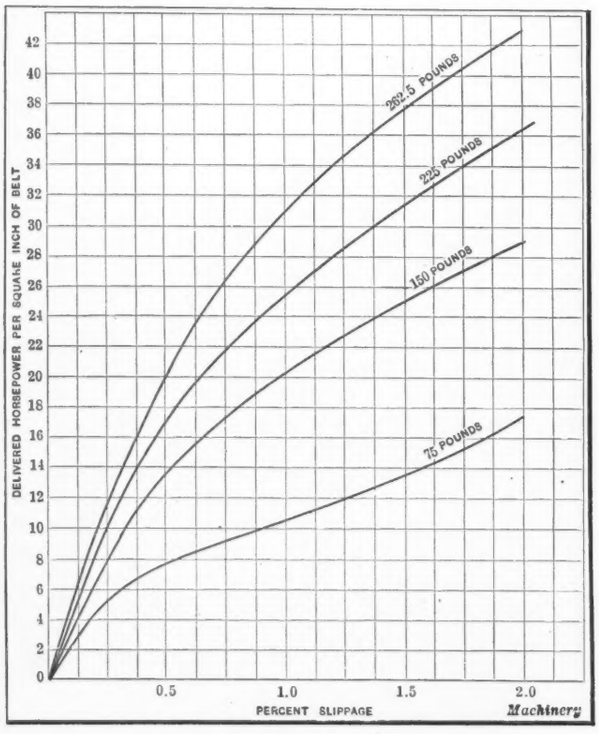


Fig. 3. Chart showing Horsepower of Reclaimed Leather Belting running at a Speed of 3000 Feet per Minute and having Different Initial Tensions

the belt to hug the pulleys closely and transmit horsepower effectively. When operating where oil is likely to get on the belts, the fabric backing acts as a wick and absorbs oil that would otherwise penetrate through a leather belt and ultimately cause slippage. Leather does not readily absorb mineral or vegetable oils. "Nu-Bilt" reclaimed leather belting is run with the hair side of the leather to the pulley, and the woven belting outward.

A series of tests conducted in the engineering department of Cornell University shows that reclaimed belting is efficient as a transmitter of power. Of course, varying humidities on different days affect the results of different tests, because climatic changes cause the initial tensions to change. This element made it desirable to conduct the tests for a sufficient number of days so that it would be possible to strike a fair average from the values obtained under various climatic conditions.

A 4-inch "Nu-Bilt" belt was used in making the tests, and three series of tests for determining the delivered horsepower at the surface speeds of 1000, 3000, and 5000 feet per minute were made, each at initial tensions of 262.5, 225, 150, and 75 pounds per square inch of belt section. The horse-

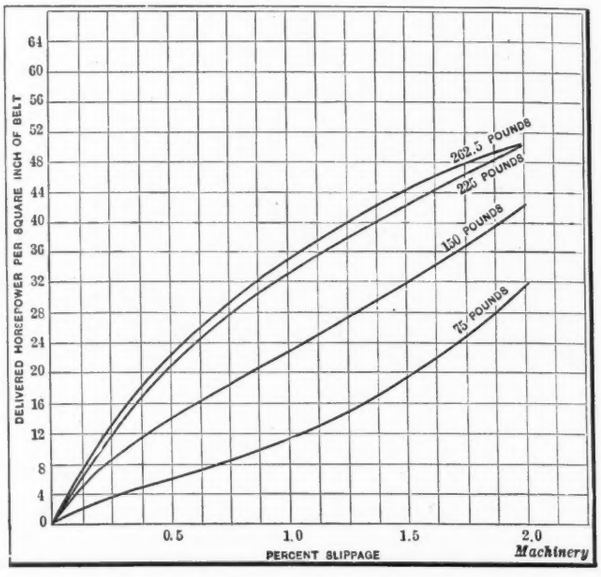


Fig. 4. Chart showing Horsepower of Reclaimed Leather Belting running at a Speed of 5000 Feet per Minute and having Different Initial Tensions

power developed and the percentage of slippage for each of these tests were plotted and curves drawn. The developed horsepower corresponding to slippages of 0.5, 1, 1.5, and 2 per cent was then taken from these curves, and these values

TABLE 1. HORSEPOWER TRANSMITTED BY RECLAIMED BELTING

Percentage of Slip	Initial Tension, Pounds per Square Inch			
	262.5	225	150	75
Test No. 1—1000 Feet per Minute Belt Speed				
0.5	5.72	4.45	2.98	2.28
1.0	7.90	6.04	3.71	2.87
1.5	9.18	6.97	4.23	3.30
2.0	10.14	7.57	4.73	3.69
Test No. 2—3000 Feet per Minute Belt Speed				
0.5	20.1	17.1	13.7	7.6
1.0	31.2	25.4	20.2	10.4
1.5	37.6	31.4	24.9	13.4
2.0	42.8	36.3	28.4	17.3
Test No. 3—5000 Feet per Minute Belt Speed				
0.5	22.5	21.3	13.8	5.9
1.0	35.1	32.6	22.4	10.9
1.5	44.25	42.5	32.1	19.3
2.0	50.1	50.3	41.9	31.4

Machinery

averaged, the results being presented in Table 1. These averages are shown plotted in Figs. 2, 3, and 4 for each of the three belt speeds. The curves are marked to show the tensions used in plotting the average in each case.

Slippage and Strength of Reclaimed Belting

The generally accepted Barth and Sellers formulas give certain horsepower values for different belt speeds and tensions. For a double-ply belt running at 1000 feet per minute, the Sellers formula gives 7.5 horsepower per square inch of belt section, and the Barth formula, 5.4 horsepower; at 3000 feet speed per minute, Sellers gives 18 and Barth 14.2 horsepower; at 5000 feet per minute, Sellers' rating is 22.7 and Barth's 13.6 horsepower. The higher values of Sellers are generally applicable to lineshaft belting, and the Barth values are those commonly used as a basis for machine tool belting from countershafts. These ratings were used to select the slippage values in the three charts shown in Figs. 2, 3, and 4, and this enables these data to be tabulated in the manner shown in Table 2. The values in the table are arranged so that a definite comparison of the amount of slippage for each of the four initial tensions under belt speeds of 1000, 3000, and 5000 feet per minute, may be made.

Although tests were run at an initial tension of 75 pounds per square inch, this low tension is not commonly used in practice except when the tension of the belt has dropped due to stretch. This initial tension would rarely be used with reclaimed belting owing to the fact that its stretch is negligible and it will maintain a high tension.

TABLE 2. SLIPPAGE PERCENTAGES OF RECLAIMED BELTING

Belt Speeds, Feet per Minute	Initial Tension, Pounds per Square Inch				Initial Tension, Pounds per Square Inch			
	262.5	225	150	75	262.5	225	150	75
	Sellers Rating				Barth Rating			
1000	0.89	1.93	....	....	0.45	0.77	....	....
3000	0.43	0.54	0.98	....	0.37	0.38	0.51	1.58
5000	0.51	0.55	1.00	1.66	0.28	0.27	0.48	1.32

Machinery

Tension Test for Breakage

Two breakage tests between two-ply leather and "Nu-Bilt" belting were made for the Brown-Lipe-Chapin Co., Syracuse, N. Y. In one test the reclaimed product broke at a stress of 4050 pounds per square inch, and the leather at 4900 pounds per square inch; in the second test the breaking points were 3900 pounds per square inch for "Nu-Bilt" and 4150 for the double leather. In the first test the elongation in reclaimed leather was 0.10 inch per inch of length, and for leather 0.215 inch; in the second test the respective elongations per inch of length were 0.095 and 0.21 inch. It will be noted that the stretch of the leather belting was more than double that of the reclaimed belting. The results of the second test indicate that there is but slight difference in the strength of the two belts.

Application of Reclaimed Belting

Reclaimed belting is used in a large variety of installations in many of the largest plants in the country, where it is reported to be rendering excellent service. Such machines as turret lathes, automatics, and milling machines are equipped with belting of this kind, and it is also said to be particularly satisfactory in connection with motors and grinders.

In Fig. 5 is shown the application of a 6-inch "Nu-Bilt" belt which is used for driving the top head of a 12-inch molding machine made by the American Wood Working Machinery Co. The machine is in operation at the plant of the Wilson & Green Lumber Co., Syracuse, N. Y. Another installation of this belting is shown in Fig. 6. This view was taken in the plant of the Endicott Forging & Mfg. Co., Endicott, N. Y., where the belting is being used for driving Bradley hammers. It will be seen that the belt is running from a flanged pulley to a pulley on the lineshaft. A belt guide is employed, but the edges of the belt are not curled or frayed to any extent.

One section of the plant of the Greiner, Semon, Lowry Co., Syracuse, N. Y., is shown in the heading illustration. This view shows the main drive motor, as well as shapers, drilling machines, engine lathes, and milling machines, all being driven from the lineshaft by "Nu-Bilt" belting.

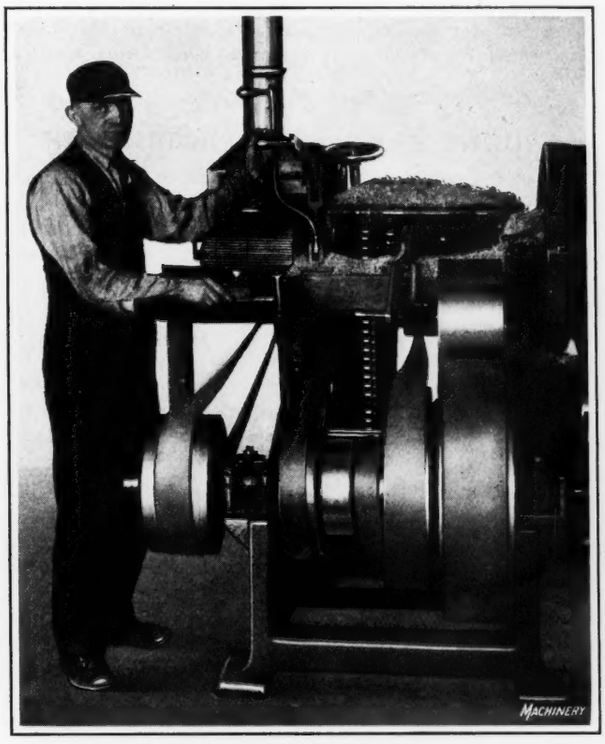


Fig. 5. Reclaimed Belting in Use on a Woodworking Machine

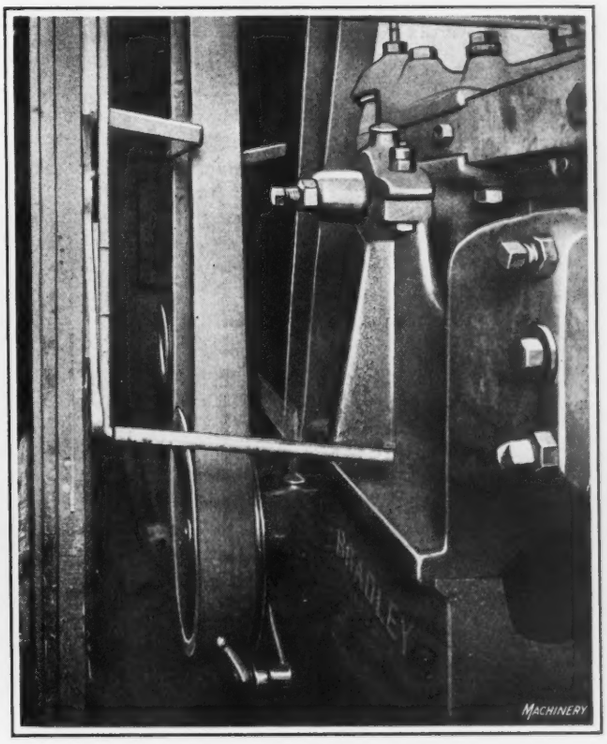


Fig. 6. Helve Hammer driven by Reclaimed Belting

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WHAT IS NORMAL BUSINESS?

During a recent trip through the West the writer asked a considerable number of machine tool manufacturers for their definition of "normal business." One said three times the amount (in value) of their sales for 1914; another two times; another 50 per cent more; another twice their average annual sales for 1910, 1911, 1912, and 1913; another suggested that if the sales curve were taken for the ten years preceding 1915 and continued through the six years following, not at the war prices or output, but at the average increase for the preceding ten years, the point reached by the curve at the present time would represent present normal business. For purposes of comparison it seems simpler in each case to use a value basis and to allow for the difference in price between the periods to be compared.

Now comes the Manufacturers' Association of Connecticut, which has worked out a method as follows: Each plant should determine the number of employes required to operate its present equipment and the number of regular working hours per week. The product of these two gives the number of man hours per week when the plant is in "normal" operation. To estimate the percentage of normal at which the plant is actually operating at a given time, the actual average number of employes at that time, multiplied by the actual number of working hours gives the total of man hours. The proportion this bears to the normal number of man hours will indicate the percentage of normal at which the plant is operating. Instead of "normal business" this is really capacity production, and we know that many plants have greater capacity, or more equipment than is required by any reasonable estimate of normal business.

Who has another method?

* * *

THE EFFECT OF HIGH FREIGHT RATES

The general belief that the high cost of transportation is one of the most potent factors in retarding business improvement is strengthened by a consideration of the effect of present freight rates upon the cost of machine tools, which, in common with many other manufactured articles, carry from three to six freight charges on the raw material and the various products that enter into their manufacture, thereby greatly increasing the cost to the purchaser.

The increased cost of transportation as it affects the machine tool business is shown by the following examples of freight charges on machine tools in 1914 as compared with 1921, and also freight charges on some of the principal materials used in the machine tool business—steel bars, pig iron, and coal—Cincinnati being used as a center.

The transportation of an 18-inch by 8-foot lathe to New York now costs $48 against $22 in 1914; a 24-inch by 10-foot lathe, $93 against $42; a 4-foot radial drilling machine, $120 against $48, and a carload of machine tools, $136 against $62. The rates from Cincinnati to Chicago are in about the same proportion, $31 against $14; $59 against $27; $78 against $30.

The effect of freight rates on the cost of material is even more marked. In 1914, a 50-ton carload of steel bars at the mill cost $1100; in November, 1921, it cost $1550, or approximately 40 per cent more; but the freight on this carload of steel had increased more than 110 per cent—from $158 to $334.75. A carload of coal cost at the mine in 1914, contract price, $37.50, and in November, 1921, $70; but the freight to Cincinnati, which was $50 in 1914, rose to $108.15 in 1921.

Freight rates must come down before prices can be reduced generally, and every help that the Government continues to give the railroads to reduce their operating expenses by abrogating unreasonable working rules and by reducing railroad pay to a level with wages paid in other lines of industry will help to benefit all classes of the people.

* * *

RUINOUS COMPETITION

Business conditions have caused the revival of some objectionable trade practices in the metal-working industry which have resulted in almost ruinous competition between manufacturers in various lines. In one instance, recently brought to our attention, four bids were submitted for the manufacture of certain metal products, the lowest bid being $2100 and the highest $2450. Nothing below the lowest bid could have been considered a fair price; yet upon being told the figures, the three highest bidders offered to reduce their quotations, virtually forcing the lowest bidder, in turn, to reduce his figure also, until finally the order was placed with him at $1500.

Through the operation of this pernicious practice the contract was finally awarded to the lowest bidder at less than actual cost, a price-cutting war was inaugurated in which all the manufacturers will inevitably lose a large amount of money, and a new price level was established below the point where there is any profit, the manufacturers having played into the hands of the purchasing agent, who in future will work his advantage for all it is worth.

Times of depression always bring out harmful and objectionable business practices which it sometimes requires years of normal business to eradicate. After much labor and research, manufacturers adopt mechanical standards which they would never think of discarding, and for their own protection they should not rashly discard standards of business procedure, especially in regard to competitive practices.

* * *

UNIONS HAMPERING PRODUCTION

One of the questions that must be settled in the railway shops is the extent to which unions shall continue to be permitted to restrict production. In a railroad shop in the Middle West, machinery was installed that produced from 3000 to 4000 parts a day of one article used in great numbers in railroad work. The makers of the machinery employed, devised an automatic machine capable of producing 20,000 parts a day, which was installed and proved its efficiency; but when it became evident that production would be increased at least fivefold, the unions protested so effectively that the use of the automatic machine was discontinued, and it now stands idle.

When the cost of railroad operation is increased because union labor refuses to permit the use of modern improvements and labor-saving machinery, we all suffer. The railroads increase their rates to cover the resulting loss, other costs rise, industry is hampered, unemployment in other industries increases, and even in the railroad shops themselves there is less opportunity for work, as present conditions show, and so it goes throughout the vicious circle.

While some of the most objectionable of the rules in the National Agreement between the railroads and the unions have been abrogated by the Railway Labor Board, many objectionable features have been retained.

Work and Thrift—Watchwords for 1922

THE New Year opens under clearing skies, national and international. The world is wiser, if chastened, and one thing it is now sure of is that the glory of war is one of humanity's great illusions, and there must be no more of it. And right here in America where the love of peace is a national characteristic and ideal, we have learned that we cannot have it, however much we cherish it, by merely holding aloof from our neighbors. So we have been talking things over with them and find them eager for our friendship and quite willing to reduce their armaments and sign up for universal peace, if assured of our continued interest and good will.

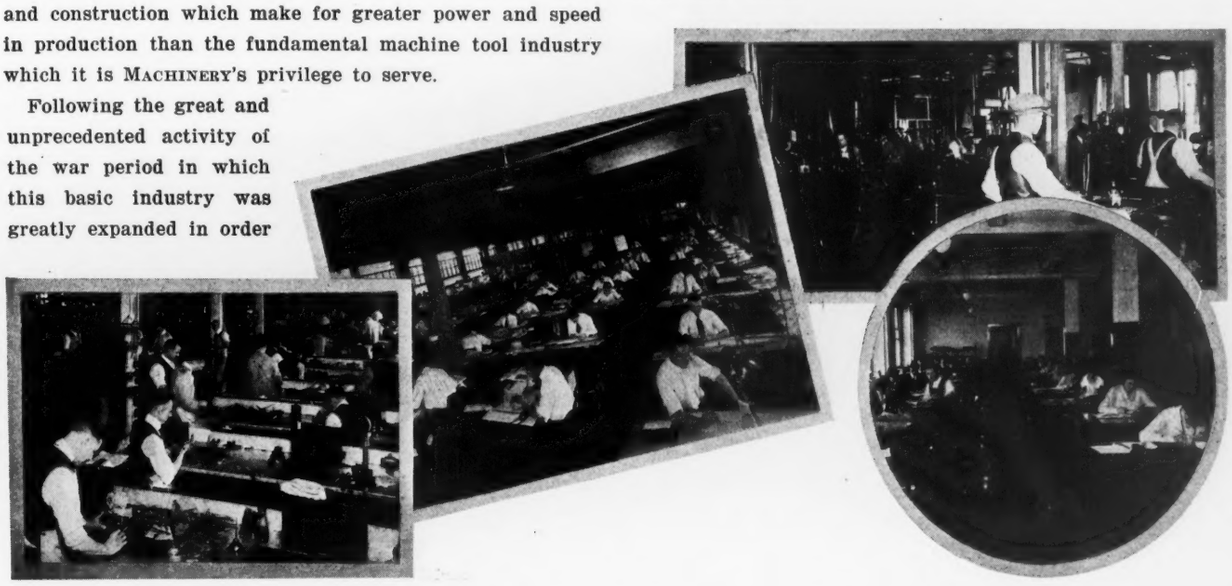
Nor can we trade with neighbors impoverished after a world war in which forty million men were under arms and whole populations enlisted for the production of war munitions. A great wild splurge it was while it lasted, and the bill has hardly begun to be paid yet. But the progress of mankind, political and economic, since the guns were silenced and the trenches vacated, has been amazingly swift, considering what there was to be done and the debris, turmoil and confusion out of which the victorious no less than the vanquished had to lift themselves.

Serving the industries as MACHINERY does, it is exhilarating to note the marked progress in mechanical methods and devices during the past year or two. It is not the spectacular discovery, or even the application of some new force or element, that immediately and directly benefits the mass of mankind, but the thousand and one ideas and improvements developed in prosaic mechanical practice, which improve, multiply and cheapen the manifold products of industry and thus increase the measure of comfort among the people. Wonderful is the flying machine and great must be its future, but of greater direct benefit to the greatest number is a good washing machine made cheap enough for the poorest. Along this line the country is moving, and no industry shows greater progress in the details of design and construction which make for greater power and speed in production than the fundamental machine tool industry which it is MACHINERY'S privilege to serve.

Following the great and unprecedented activity of the war period in which this basic industry was greatly expanded in order to accomplish its vital work for the production of munitions there have been nearly two years of stagnation. One of the last of the industries to recede from the peak, it is one of the last to turn toward prosperity again. Small tools and accessories, the vanguard of the metal-working industry in the forward march, are doing a better business, and in other lines of industry various branches are well along the road to prosperity. The machine tool industry serves them all, and when the turn has come for them the turn for this basic industry cannot be far away.

It is a fact that after every depression recovery in the machine tool industry has been more rapid than was expected. There is not a great deal of war machinery to be released, either government or private, and there is a great deal of "hold-back" in buying of shop equipment. The world never stands still; consumption goes on incessantly, and the purchase of machine tools as well as commodities of every description must follow the inexorable law of supply and demand. The year 1921 will stand out a heavy black mark in the annals of the machine tool industry, but that is behind us, and 1922 will unquestionably lay the basis for a period of prosperity in this industry.

The industry has its troubles like every other, but is operated by practical people who know how to work definitely for practical results. They are not much given to theory, except the theory that underlies and makes possible modern mechanical practice. They believe in work. A great many good people believe that religion will save the world; others think prohibition can, or did think so; socialism in all its varieties has many advocates; but MACHINERY believes with the Machine Tool Industry, that the sovereign remedy for social and economic ills is just plain hard WORK, plenty of it—and THRIFT. Evidences multiply that people generally are returning to these fundamentals. The year 1922 should be a great year for men and for nations endowed with horse sense.



New Type of Thread Plug Gage

A THREAD plug gage of a design embodying a number of new features, which is manufactured by the Hartford Tap & Gauge Co., Hartford, Conn., is shown in the accompanying illustrations. This gage can be supplied in a number of different combinations, as for example, with a standard thread plug gage on one end of the hollow handle, and an over-size thread plug gage on the other end, or with a thread plug gage on one end and a plain plug gage of the same diameter as the tap drill used in producing the hole in the work, on the other end. The handle may also be provided with only one gage and used as a single-end gage. The thread of gages generally wears first on the end that enters the hole in the work, and so provision is made for reversing the threaded plugs as they become worn so that they will have a longer life.

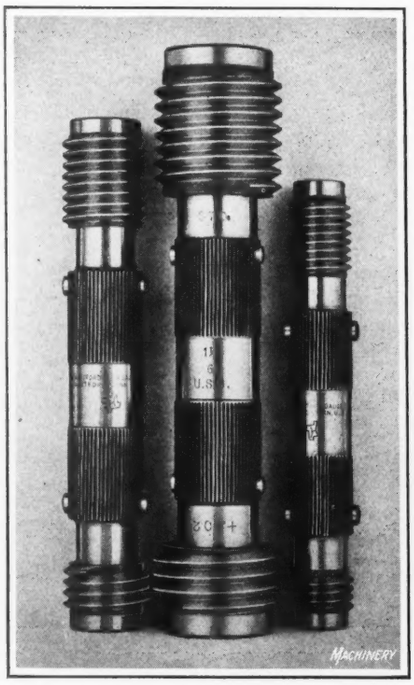


Fig. 1. Reversible-end Thread Plug Gages

Each plug is mounted on a screw which has a head of approximately the same diameter as the bottom diameter of the thread on the plug. This screw fits into a nut held in the handle by means of a taper pin, as shown in Fig. 2. The threaded plug is rigidly attached to the handle by tightening the screw. The taper pin is first driven back so that its large end projects about 5/16 inch from the side of the handle; then the screw is tightened with an ordinary screwdriver, after which the taper pin is again driven into the handle until the large end extends approximately 1/16 inch. Thus the taper pin is driven a distance of about ¼ inch. The driving of the taper pin into place causes the nut to be drawn back into the handle and creates a tension in the screw so that the gage and the handle are held tightly against each other. A small pin driven into the ends of the handle projects into a small slot on the face of the gages. This locks the members together in such a way that they will not work loose.

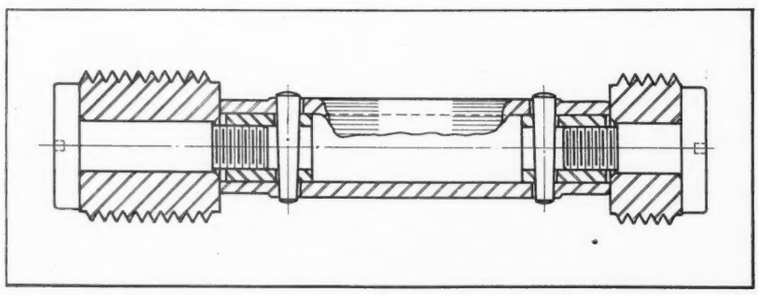


Fig. 2. Sectional View showing the Method of attaching the Threaded Plugs to the Hollow Handle

All parts of the gage, including the taper pins, are hardened. The thread on both ends of the plugs is milled off until a full form is reached. This will be seen by referring to the gages illustrated in Fig. 1. By this construction, any dirt that happens to be in a hole to be gaged will be scraped off by the thread of the plug as the latter is inserted in the hole. As the handle is hollow, the gage is comparatively light in weight, and by making the diameter of the screw heads approximately the same as the diameter of the bottom of the thread on the gage ends, it is unnecessary to provide a special pilot for the plug.

Although the first cost of a gage of this design is more than that of a solid gage, the possibility of renewing the gage ends and using the handle, screws, nuts, and taper pins indefinitely is an economy in cases where a gage is subjected to severe use. The thread plugs are finished without lapping by means of a new grinding method known as the "Hanson process" producing a fine finish and threads of accurate form. The gage ends are manufactured in various sizes from ½ to approximately 6 inches in diameter, and with U. S., V, Acme, and Whitworth threads. This new type of thread plug gage was designed by B. M. W. Hanson.

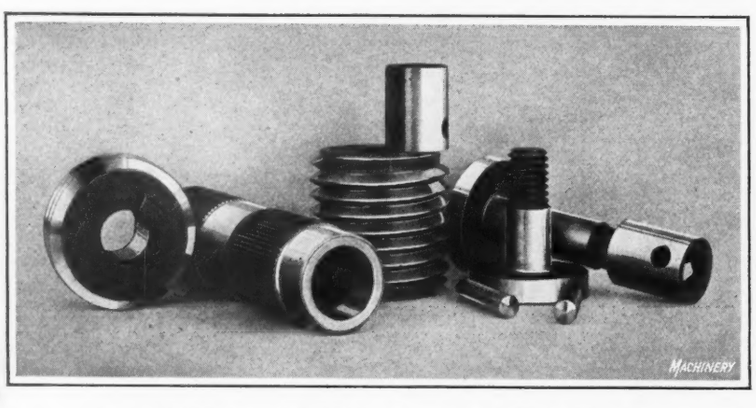


Fig. 3. Parts of the Hartford Tap & Gauge Co.'s Thread Plug Gage

The more rigid requirements in interchangeable manufacture which prevailed during the period of the war, and which since then are being more and more adhered to in many lines of manufacture for peaceful pursuits, have increased the demand for accurate gaging means, and mechanical men generally will be interested in the details of new designs.

* * *

On December 16 the Keller Mechanical Engraving Co., Brooklyn, N. Y., through its vice-president, Jules Dierckx, presented to President Harding a bronze medallion bearing on one side the portrait of the President and on the other side an expression of the sentiments of the times. The original of the medallion was modeled in wax by Frederick Kaupmann, Jr., and from a mechanical point of view the reproduction is unique in that the dies were cut on an automatic machine and not by hand, as is the usual practice. The occasion commemorated the twenty-fifth anniversary of the founding of the Keller Mechanical Engraving Co.

Reducing Costs by Continuous Milling

CONTINUOUS circular milling presents one method by which production costs can be reduced to the minimum in milling when the work lends itself to ready loading and unloading on a rotary fixture without stopping the machine, and when the operation may be accomplished as the parts are conveyed by the rotating table past the cutters. The efficiency of continuous milling as regards the average amount of time required for machining a part will be emphasized in this article, which illustrates a number of operations of this class performed on single- and double-spindle milling machines of the vertical continuous type, built by the Newton Machine Tool Works, Inc., Philadelphia, Pa. The distance between the spindles of double-spindle machines varies, but in each case it is sufficient to permit long pieces to be completely rough-milled before a finishing cut is begun on the same part. Owing to the fact that the work is turned on the axis of the fixture as it is presented to the cutters, a shearing action of the cutters is produced, which accounts for the high rates of feed obtainable.

In the examples to be presented, the possible production per hour, the average production per day based on an efficiency of 90 per cent, and a piece cost based on a labor rate of 70 cents per hour will be given. An operation in which a double-spindle machine is employed to advantage is illustrated in Fig. 1; this consists of milling camshaft thrust blocks. The fixture holds ninety-six pieces at one time, and as they are traversed past the set of cutters on the first spindle, flats are machined on the top and bottom of the projecting ends. The second set of cutters bevels the front ends of these flats. In this operation the table feed is 5 inches per minute, so that 413 pieces may be machined per hour or 2973 per eight-hour day, based on the efficiency previously mentioned. The average labor cost per piece is 0.19 cent. It will be seen that four blocks are clamped in place by means of one bolt which controls two clamps. The pieces are seated in rounded grooves, and the shoulders on the opposite ends to those machined bear against the inside of the fixture, so that the work projects the required amount.

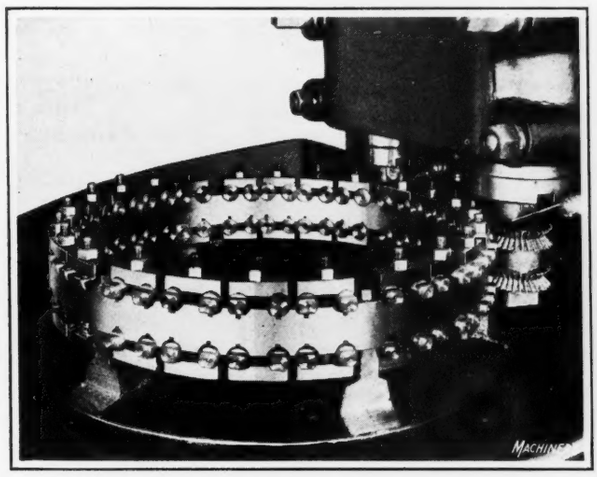


Fig. 1. Operation in which One End of Camshaft Thrust Blocks is flatted and beveled

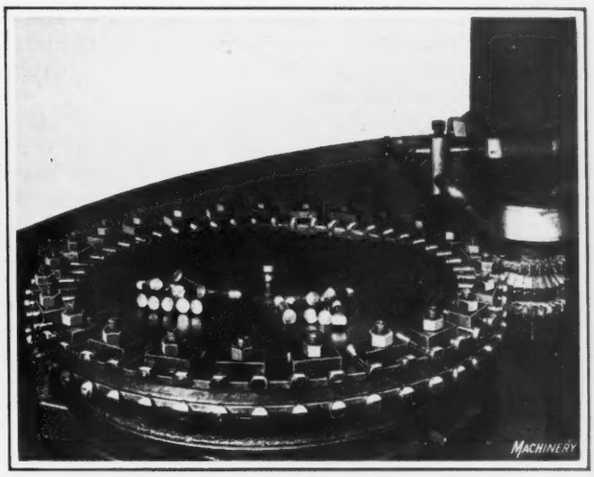


Fig. 2. Fixture for holding One Hundred Connecting-rod Bolts on a Single-spindle Machine

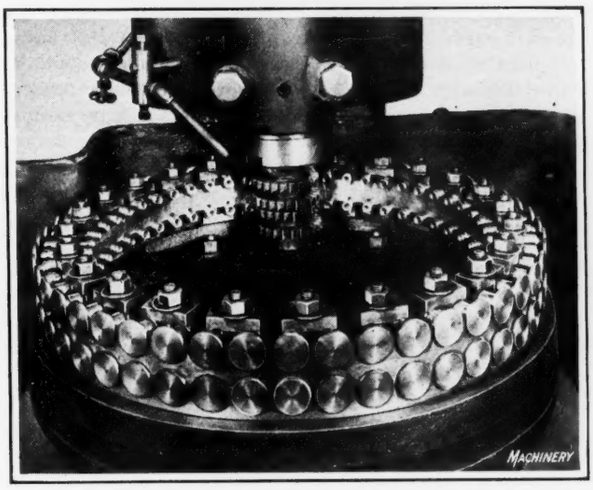


Fig. 3. An Operation on Valve Lifters, the Cutter-spindle being located within the Work Fixture

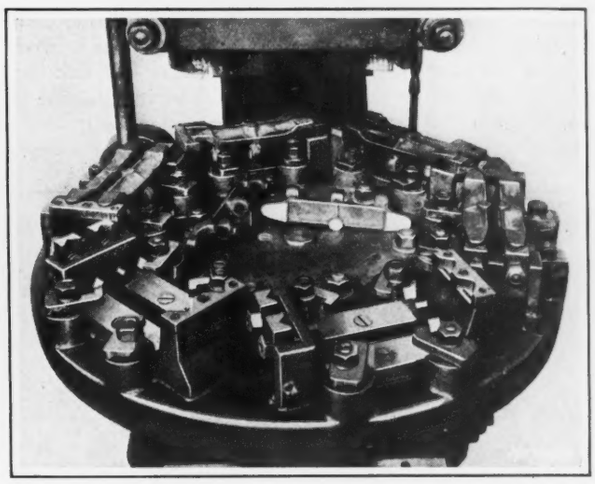


Fig. 4. First Operation on Valve Rocker-arm Brackets in which the Bottoms are machined

Automobile connecting-rod bolts have the head milled flat on one side and beveled on the other in the operation illustrated in Fig. 2, which is accomplished on a single-spindle machine equipped with four cutters. The fixture has a capacity for 100 bolts, and four pieces are held in place by two clamps and one bolt, as in the preceding operation. In this case the bolt heads register against the outside of the fixture. The table feed is 8 inches per minute, and a produc-

tion of 625 pieces per hour is possible, or an average production of 4500 pieces per day, the labor cost being 0.13 cent per piece.

Another 100-piece fixture is illustrated in Fig. 3, which shows an operation on the small ends of valve lifters. In this case the milling cutters are inside the fixture, whereas in the preceding examples they were located outside. The table feed in this operation is 12½ inches per minute, so that a production of 1194 pieces per hour is obtainable, or an average of 8600 pieces per day. This brings the labor cost per piece to 0.065 cent.

An operation on cast-iron valve rocker-arm brackets is performed on a machine provided with the rotary fixture shown in Fig. 4 in which the ends of the pieces are clamped in V-blocks drawn together by means of a bolt, while other clamps bear against bosses on the work. The operation consists of milling the feet and a boss on the bottom of the brackets. There are six stations on the fixture, each of which holds two pieces. At a table feed of 15 inches per minute, the production per hour is 120 pieces or 864 pieces per day, the labor cost being 0.65 cent.

A second operation on the valve rocker-arm brackets, which is somewhat more complex than any of the others described, consists of machining the faces of three bosses. This set-up is not illustrated. The fixture accommodates twenty-two brackets, the pieces being seated on the surfaces machined in the operation illustrated in Fig. 4. While the three boss faces at one end are parallel with each other and those at the other end are also parallel, the faces of both sets are not parallel. On account of this condition only three faces can be machined in one traverse past the cutters, the other three being milled by reversing each bracket for a second traverse. By this method the twenty-two pieces are completed in two revolutions of the table, and with a feed of 4 inches per minute a production of thirty-five pieces per hour is possible. At the rate of 252 pieces per day, the labor cost per piece is 2.22 cents.

A fixture designed for holding cast-iron covers for a pump gear-box is shown in Fig. 6. The covers are surface-milled at the rate of 18 inches per minute, which gives a production of 114 pieces per hour or 821 pieces per day, at a labor cost of 0.68 cent per piece. The portion of the castings projecting into the fixture is forced against a steel plate by means of an adjustable steel plate, actuated by a screw.

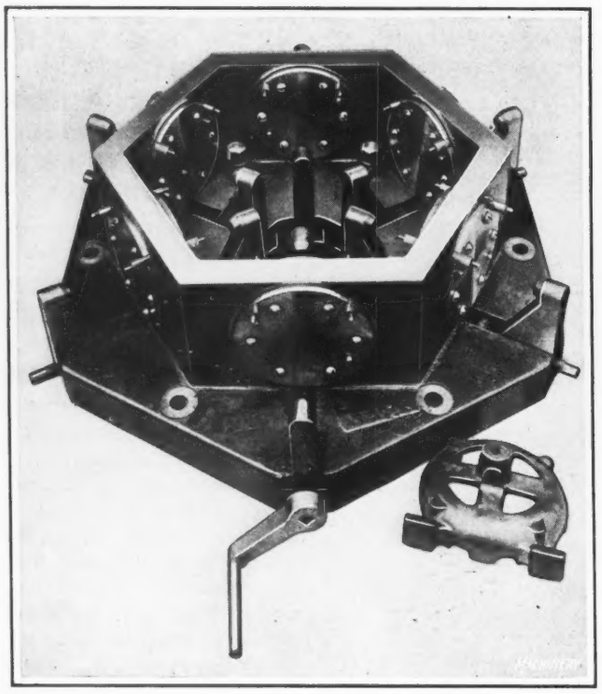


Fig. 5. Fixture for holding Motor Guards while machining the Feet

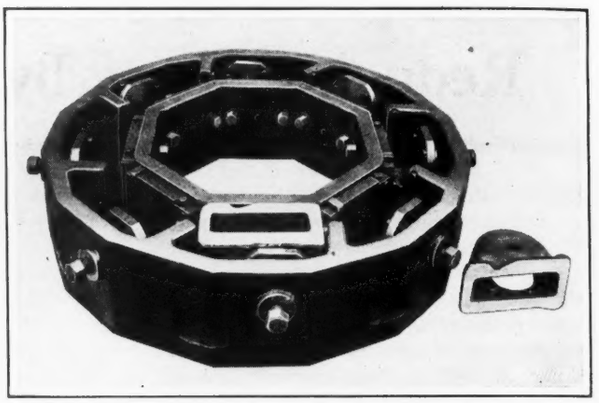


Fig. 6. Fixture designed for holding Covers for Pump Gear-cases

The fixture presented in Fig. 5 is employed in the continuous milling of end shields for electric motors, one of these parts being shown in front of the fixture. An internal surface of the work is machined to fit circular plates attached both to the outside and inside of the fixture, and at each station two parts are held on these surfaces by two clamps operated through a single screw that is turned by means of a crank-handle. The operation for which this fixture is employed consists of milling the feet of the shields, and this is accomplished at a feed of 30 inches per minute which gives a production of 313 pieces per hour or 2254 per day, at a labor cost of 0.25 cent per piece.

* * *

STANDARDIZATION AS A MEANS OF CUTTING PRODUCTION COSTS

Simplification is probably one of the most important means of cutting production costs, but it cannot be accomplished by the individual manufacturer without the wholehearted support of the financial, sales, and production executives. To obtain the greatest reduction in cost it is necessary, however, that such simplification be carried beyond the plant of the individual manufacturer to include the entire industry. Cooperative simplification between manufacturers, or standardization, can be carried out most advantageously through the medium of trade organizations.

In the automotive industry the Society of Automotive Engineers, functioning through its standards committee, has made possible this coordination of effort which has resulted in the application of standards and consequently the cutting of production costs to a great extent. Additional standards, each representing a possibility of reduced costs, will be acted upon at the standards committee meeting on January 10 in the Engineering Societies' Building, New York City. Sixteen divisions representing different fields in the automotive industry and parts or material manufacturers will present over thirty proposals for adoption as standards. The iron and steel division will submit a complete revision of the present iron and steel specifications. The revised report is based on a great number of laboratory tests carried out throughout the country. The following parts and materials are included in the various reports: Ball bearings, roller chains, sprocket cutters, generators, insulated cable, starting motors, carburetors, fan belts and pulleys, mufflers, running boards, iron and steel specifications, non-ferrous metal specifications, rod-ends, lock-washers, pressure gages, pneumatic tires, clutch facings, tire pumps, and three-joint propeller shafts.

* * *

The Danish Government is reported to have discontinued negotiations looking toward a trade agreement with Russia, while Sweden still continues to bargain with the Soviets in the hope of securing a satisfactory commercial treaty. Norway has concluded a commercial treaty with Soviet Russia.

Mechanical Engineers' Annual Meeting

THE keynote of the annual meeting of the American Society of Mechanical Engineers, held December 5 to 9, in the Engineering Societies' Building, 29 W. 39th St., New York City, was the prevention of waste in industry. A great many of the papers read before the society pertained to this subject. The address by the retiring president, Edwin S. Carman, dealt with the subject of industrial relations, and great stress was laid upon the necessity of paying greater attention to the human factor in industry. The engineer must not only concern himself with scientific and mechanical facts, but must broaden his views as to his position in industry, so as to aid in the solution of the greatest problem now requiring attention in the field of production. Some common ground must be found between employer and employe, and the engineer must fit himself to be able to aid in formulating the proper means whereby this can be accomplished.

Salvaging Industrial Waste

The machine shop division had prepared a program of three papers, all of which awakened a great deal of interest. The subject of salvaging industrial waste was dealt with by J. A. Smith, general superintendent of the General Electric Co., Schenectady, N. Y. Attention was called to the great amount of waste in ordinary machine shop operation, due to not taking care of metal and other material waste. Furthermore, a great deal of waste is due to negligence of repair and maintenance work. The author emphasized the fact that systems must be set up governing the distribution and repairs of the various classes of small tools so that the consumption of these will be regulated within certain defined limits of economy and efficient service, in accordance with production requirements in the shop.

It is good practice to make regular monthly inspections of machine tools and equipment, and make a record of these inspections, in order that repairs may be made promptly at a minimum of cost before the damage becomes more serious or breakdown ensues, with increased repair expense and added delay to production. The record is valuable as showing the relative cost of maintenance and the relative life of service of various makes of tools. It is often good economy to replace a tool showing high maintenance cost with a new tool of some other make, and thus save both expense and delays to production. In all cases of replacements and repairs, valuable parts should be salvaged and made use of on other jobs of repair work, wherever practicable.

In supplying small tools to the shop, much can be accomplished in the way of reducing expense by efficient methods of distribution and collection. A system of regular inspection of tool-rooms, tool cupboards, benches, and areas around machine tools should be established in all departments. Tools not needed for immediate or current use should be promptly returned to stock, and those needing repair put into shape for further requirements. This is particularly important in the case of high-speed-steel tools where the cost is relatively high by comparison, and a single idle tool may represent a good many dollars of tied-up capital. By a properly organized system of distribution and collection, the inventory of tool stocks carried may be greatly reduced, expenditures for new tools curtailed, and those in use in the shops kept more constantly in active service.

The author also laid emphasis on the fact that the question of profit should not always be a deciding factor in considering the saving of materials, but that operations must be conducted with a broader view of saving everything which may be of value whether immediate, direct profit is gained or not. The manufacture and supply of raw materials depends so often upon the supply of various kinds of scrap and waste that it is most essential that consideration be given to the country's needs as a whole and that efforts at salvage work be not limited to the desire for immediate profit. Indirectly benefit will be received through reduced cost of raw stocks, because of the abundance of original materials which are thus created.

Still another phase of salvage work which is distinct and apart from the field of salvaging metal scrap and other factory wastes, is the saving of time and human effort, and of mental and physical energy. Profitable manufacturing requires that we build up our organizations both in offices and in the factory with a view to concentrating directive effort, eliminating duplication of orders and instructions, establishing unity of purpose, system in method of procedure, and cooperative effort on the part of all employes, whether serving in official capacities or in the lower grades of mechanical and physical labor.

Waste in the Machine Industry

An address that aroused a great deal of enthusiasm because of its relation to the human rather than the engineering side of shop operation, was that by J. J. Callahan, general manager, Passaic Metal Ware Co., Passaic, N. J., on "Waste in the Machine Industry." In this address Mr. Callahan pointed out that if the management of any industrial undertaking desires the cooperation of its employes, this can be obtained by creating a spirit of mutual confidence and by arousing the interest of the employes in the success of the business enterprise by giving them an opportunity to take an active interest in the development and application of improved methods and facilities. He gave numerous examples of successful application of such cooperation both in the plant with which he is connected and in other manufacturing establishments. An article explaining in detail the plan that Mr. Callahan has installed in his own shop in Passaic, was published in November, 1919, MACHINERY, entitled "Representative Government in a Manufacturing Plant."

The Art of Milling

A paper giving particulars of an investigation undertaken at the University of Michigan for the purpose of finding a rational basis for the action of a milling cutter was presented by Professor John Airey, Ann Arbor, Mich., and Carl J. Oxford, mechanical engineer, National Twist Drill & Tool Co., Detroit, Mich. In this paper it is shown that metal is removed more efficiently with thick chips than with thin chips. It follows from this that, other conditions being equal, including speed and feed per minute, the cutter with the fewest teeth gives the greatest efficiency. However, it is evident that the efficiencies of two cutters with different numbers of teeth are equal, provided the table feeds be adjusted so that the same feed per tooth is effected. This gives a definite working theory on the influence of spacing.

It is definitely established that for a given material, tooth shape, and sharpness, thickness of chip is the sole criterion of the efficiency with which metal is removed in milling and that increase of spacing over that required for free cutting is a handicap. Present-day high-powered cutters have several times the chip space needed. Limitation of machine power has doubtlessly been the chief factor in giving a false bias to the influence of spacing. Formulas for determining the number of teeth for a known diameter of cutter and for determining the depth are included in the paper, as well

as a geometrical construction for obtaining the best shape of tooth.

The authors pointed out that the industrial value of scientific analysis applied to basic shop processes appears to be little appreciated when that analysis is contrasted with investigations carried on to improve the design of the manufactured product. This is explained partly by the cleavage between the engineering department and the operating department in almost all plants. It is also partially explained by a shrinkage in the significance of the term "engineering" until it means "design" only, when used in a quantity-production atmosphere. This is either the cause or the effect of our engineering schools keeping out of touch with production proper, and consequently research energy is lavished on all features of design, each minor side issue usually having its full quota of devotees.

In contrast to this, research endeavor covering basic shop processes appears to be badly neglected. Taylor, in this country, and Nicolson, in England, have done classical work in the field of lathe-tool action. There is much to be done, and many fundamental shop processes are yet untouched. A plea is here made that our engineering schools devote the same intensity of attention to shop processes that they now devote to design. The economic results to industry would be greater though not so spectacular. If a hole can be drilled more quickly or a surface can be milled more rapidly, then the cost of practically all classes of finished products is affected. This is true of improvements in all basic shop processes, whereas improvements in design benefit only a limited field—just one class of finished product. The economy accruing from improvements in shop processes, being distributed over a larger territory, is less spectacular, and this, indirectly, may account for the decreased attention given to it.

In the art of milling, the only published investigations have been handled by machine tool builders. Attention has in consequence been focussed more on the machine than on the cutter. This paper describes an attempt to investigate the fundamental principles underlying the action of milling. The investigation described in the paper was instituted in May, 1920, by the National Twist Drill & Tool Co., and this company furnished the financial support throughout. Experiments have been conducted in the engineering shops of the University of Michigan, at the plants of the National Twist Drill & Tool Co., the Lincoln Motor Co., and the Hudson Motor Car Co. The greater part of the work was done at the University of Michigan. A complete copy of the paper may be obtained from the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

* * *

PROPOSED BIG STEEL WORKS IN INDIA

According to information given out by W. H. Rastall, chief of the Industrial Machinery Division of the Department of Commerce, there has recently been incorporated in India by Bird & Co. of Calcutta and Cammell, Laird & Co., of Sheffield, a new concern known as the United Steel Corporation of India, Ltd., with a capitalization equivalent to $60,000,000 to $100,000,000 depending on the exchange calculated. It is believed that this development is of great importance to the future of the iron and steel industry in the East, it being proposed to establish, as soon as possible, works on a large scale near the deposits of iron, coal, and limestone in India. The cost at the works is said to be greatly below what has to be paid in other steel-producing countries, and for this reason it is believed that India will be able to produce the cheapest steel in the world. Cammell, Laird & Co., Ltd., are acting as advisors to the corporation, and are responsible for the design and erection of the works as well as of hiring employes. The plant is designed to produce 600,000 to 700,000 tons of pig iron, and the steel works and rolling mills are capable of producing 450,000 tons of finished steel a year. As a first step, however, it is proposed to erect a unit of half this capacity.

INDUSTRIAL CONDITIONS IN FRANCE

By MACHINERY'S Special Correspondent

Paris, December 10

The machine tool market is very quiet, and there is practically no buying. The only demand is for special machines, of which a few are being sold. Hence the production in the French machine tool shops is at a low level, and in the St. Etienne district, especially, a number of plants have reduced their working hours. The machine tool builders are particularly affected by the uncertainty of the policy which will be adopted by France in its dealings with Germany. Many French buyers of machine tools are deferring their purchases until German machines may be imported into France without difficulty.

At the present time, only special machines find a market, but some of these are selling steadily. This is particularly true of swaging machines, which have been placed on the market by three French manufacturers—Jouve, 3 rue de l'Orme, Paris; Chanay, 32 rue du Plat, Lyons; and Groslambert, rue de Vesoul, Besancon. These machines have given very good results.

The Allied Machinery Co. of France, 19 rue de Rocroy, Paris, has just installed in its Cail factory at Denain, one of the "Quickwork" shears built by the Quickwork Co., St. Marys, Ohio, which is said to be the only machine of its kind in France, and which has been arousing considerable interest among French engineers on account of the work of which it is capable.

The Norton Co. has built a large factory at La Courneuve, and is now supplying grinding wheels in all sizes from this plant. The quality of these wheels is exactly the same as that of the wheels formerly imported from America, the raw materials being imported from the United States. Fenwick Fréres, 8 rue de Rocroy, Paris, because of the prohibitive exchange rates with America, have taken the agency of a Belgian manufacturer of grinding machines.

General Conditions in the Metal-working Field

In general, there is a slight improvement in the metal-working industries. Slowly but steadily the plants are starting up. There has been an increase in the demand for labor in the metal-working field in the vicinity of Paris. The scale of wages at present, based upon an eight-hour day, is as follows: Unskilled labor, 14 francs; machine operators and helpers, 22 to 24 francs; milling machine and lathe operators, 27 to 28 francs; blacksmiths, boilermakers, structural iron workers, 26 to 29 francs; highly skilled mechanical workers, 30 to 33 francs.

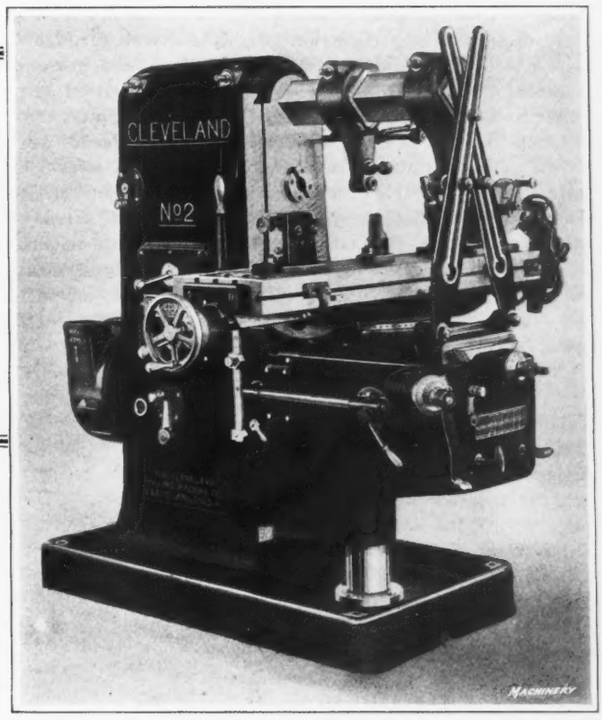
It is stated that a number of large French steel works have jointly opened negotiations with Italian works for delivery to Italy of large quantities of steel billets to be rolled into the finished product by Italian mills. The Italian Government approves of this arrangement, and a reduction is being considered in the custom duty for imports of this kind into Italy.

Considerable business is expected from the electrification of the railroads, some of the large railroad companies of France having already started to negotiate important orders in the electrical field. The Thomson-Houston Co. is figuring on a contract to manufacture 200 electric locomotives for la Compagnie d'Orléans. The same company is at present engaged in the manufacture of material for sub-stations for the Midi railroad, and is negotiating with the Paris-Lyons-Mediterranean road for similar material.

Construction Mecanique Francaise (Anciens Etablissements Cail) at Denain (Nord) is working on an order for 100 large locomotives to be completed and delivered in the course of the coming year. This company now employs 3500 men, and the production has reached 90 per cent of the pre-war output. The restoration work at Denain has proceeded rapidly, and when the new buildings have been completed the industrial plants of the city will have a larger capacity than before the war.

Design of the Cleveland Milling Machine

A Detailed Description Covering the Important Features in Design



THE efforts to produce machines to meet, in the best way possible, the demands for adaptability to a large variety of work, ease of operation, rapidity and accuracy of production, and length of service, have been largely responsible for the evolution of standard machine tools to the present-day designs. By these constant efforts the milling machine has advanced to its present stage of development. The heading illustration shows a modern machine of this type—the Cleveland milling machine built by the Clark-Mesker Co., Cleveland, Ohio. A patent covering the distinctive features of this machine has just been issued and, in view of this, it is believed that a description of the design will prove of interest to those engaged in machine tool design and to users of machine tools.

Construction of the Column and Over-arm

The column and base of the machine consist of a one-piece semi-steel casting adequately ribbed to give a rigid construction. As shown in Fig. 1, the lower portion of the column on the inside is formed into a chamber in which is kept a supply of coolant for the cutters, the coolant being conveyed to the cutters through the medium of the centrifugal pump *B* which is driven from the main driving shaft *A* through bevel gears and a vertical shaft. By driving the pump directly from the main shaft the supply of coolant to the cutters is automatically cut off when the machine is stopped. The bracket for the pump and its driving shaft is suspended from a rib which separates the coolant chamber from the compartment occupied by the main driving shaft and the speed-change gearing. A gasket is placed between the flange of the pump bracket and the rib so as to prevent oil leaking from the upper compartment into the coolant chamber. The pump forces the coolant to the cutters through piping which may be seen in Fig. 3, the coolant being later returned from the table to the chamber through a hose. The coolant chamber is filled through an opening in the right-hand side of the column which is provided with a suitable cover.

A feature of the machine is the square over-arm, the main advantage claimed for this design being that it provides a positive alignment of the arbor supports and the arbor with the other machine members. The over-arm is held snugly in the column by a cap having 90-degree V-grooves which mate with similar grooves in the column proper. The cap is aligned on the column through the use of a taper gib and dowel-pins, and the over-arm is clamped in place by binding members *C*, Fig. 1, each of which has two cylindrical parts connected by a screw that projects from the left-hand side of the column. These cylinders have beveled surfaces on the ends in contact with the square over-arm, and clamp the latter when the bearing surfaces are drawn against it by rotating the binding screw. The two arbor supports are clamped to the over-arm in a similar manner.

Lubricant for the various gears in the upper compartment of the column is supplied through opening *D*. The compartment should be filled to a level midway across a gage glass on the left-hand side of the column, which may be seen in the heading illustration below the main driving shaft. To fill to this level requires approximately five gallons of oil, but it is only necessary to do this about twice a year. A fine mist of oil is created in this compartment when the machine is running, due to the revolution of the gears.

The Spindle Driving Arrangement

Power to the cutter-spindle, the knee-elevating mechanism and the table feeds is transmitted through shaft *A*, Fig. 1, from the constant-speed pulley *E* which drives shaft *A* by means of friction clutch *F*. The pulley is mounted on the hub of the clutch-driving member, and this entire unit is supported by a bracket bolted to the rear of the column. Clutch *F* is controlled by levers *A*, Fig. 3, on each side of the column, located close to the table. The drive from the main shaft to spindle *G*, Fig. 1, is through a set of change-gears which ends in two gears keyed to the spindle. This arrangement furnishes sixteen speeds in geometrical progression, in either direction.

Power is transmitted from the driving shaft to the first gear *H* in the speed-change train, either direct through clutch *L* or through three bevel gears, *I*, *J*, and *K*, and clutch *L*. The clutch is keyed to shaft *A*, and when it is brought in mesh with the sleeve on which gear *H* is mounted, the latter is driven in a direction opposite to that in which it revolves when the drive is through the bevel gears previously mentioned. Clutch *L* is operated by a lever on the left-hand side of the column, which may be seen in the heading illustration adjacent to the oil-gage. With this arrangement only one speed, in either direction, can be transmitted to shaft *M*, Fig. 1, this being accomplished by means of the gear at the rear end of shaft *M* which meshes with gear *H*.

Two sliding gears *U* and *V* on shaft *M* and four gears which are held stationary axially on a sleeve *N* that revolves on a shaft enable any one of four speeds to be transmitted to the sleeve. From this sleeve power is transmitted to shaft *O* through two pairs of sliding gears *W* and *X*, which mesh with gears keyed to sleeve *N*. Sliding gears *W* and *X* have clutch teeth on both ends, and when gear *W* is pushed to the rear, the clutch teeth on this end engage similar teeth on gear *Q*, thus driving this gear directly.

When the sliding gear is brought to the front its teeth engage those of clutch *P* so that gear *Q* is driven through the clutch and the sleeve on which the clutch and gears are mounted. Similarly sliding gear *X* drives gear *R* either through the clutch teeth mounted adjacent to this gear or through clutch *P*. Gears *Q* and *R* mesh with gears keyed to the spindle, and as gear *Q* is mounted on a sleeve, and gear *R* really consists of a sleeve with teeth cut on one end, when either of these gears is transmitting the drive, the other rotates idly on shaft *O*. The sliding gears on shafts *M* and *O* are operated by ball-joint levers *A*, Fig. 4, located on the left-hand side of the column. The forks operating the sliding gears are made interlocking so as to prevent the engagement of both pairs of gears at one time.

Adjustment of the Spindle

The spindle is flanged at the front end, and the face of this flange has a keyway into which may be inserted hardened steel jaws for driving arbors and face mills. Wear on the front and rear spindle bearings may be compensated for by adjusting nut *S* (Fig. 1) at the rear end of the spindle. The spindle may be hand-operated by turning wheel *T*, which is a convenient feature when boring jobs and some milling operations are being performed. Positive locking of the spindle is effected through a small crank-lever on the left-hand side of the column near the rear, which may be seen in the heading illustration. This locking device cannot be operated while the machine is running, and neither can the main driving clutch *F*, Fig. 1, be brought into contact with its driving member when the spindle is locked. The positive locking feature enables the operator to remove arbor nuts without difficulty. The draw-in bolt *Y* provided for holding arbors or cutters in the socket end of the spindle may be rotated by applying a crank-handle on the rear squared end.

The Knee-elevating Mechanism

Reference to Fig. 2 will show that the gearing for elevating or lowering the knee and feeding the saddle and table is all contained in the knee, the latter consisting of a main casting gibbed to a dovetail slide on the column, and a casing *A* in which the major portion of the gearing is contained. This construction enables ready unit assembly and facilitates lubrication of the transmission members, as a sufficient quantity of oil can always be kept in casing *A* for some of the feed-gears to dip into. Power is transmitted to the knee-elevating and table-feeding mechanisms from shaft *A*, Fig. 1, through bevel gears *a* and *b*, and spur gears *c* and *d*, gear *d* driving the extremely wide faced spur gear *B*, Fig. 2. The extreme width of gear *B* is necessary on account of the vertical movement of the knee. Gear *C* also meshes with gear *B* and transmits power to shaft *D* through bevel gears, the drive being connected and disconnected by operating clutch *E*, which is controlled by a lever on the left-hand side of the knee. When clutch *E* is in engagement with bevel gear *F*, the rotation of shaft *D* is in the opposite direction to that in which it revolves when the clutch is in engagement with gear *G*. This arrangement enables the knee to be elevated or lowered, the saddle fed to the front or rear, and the table to the right or left.

From shaft *D* power for operating the knee mechanism is transmitted to sleeve gear *H* through trains of feed-change

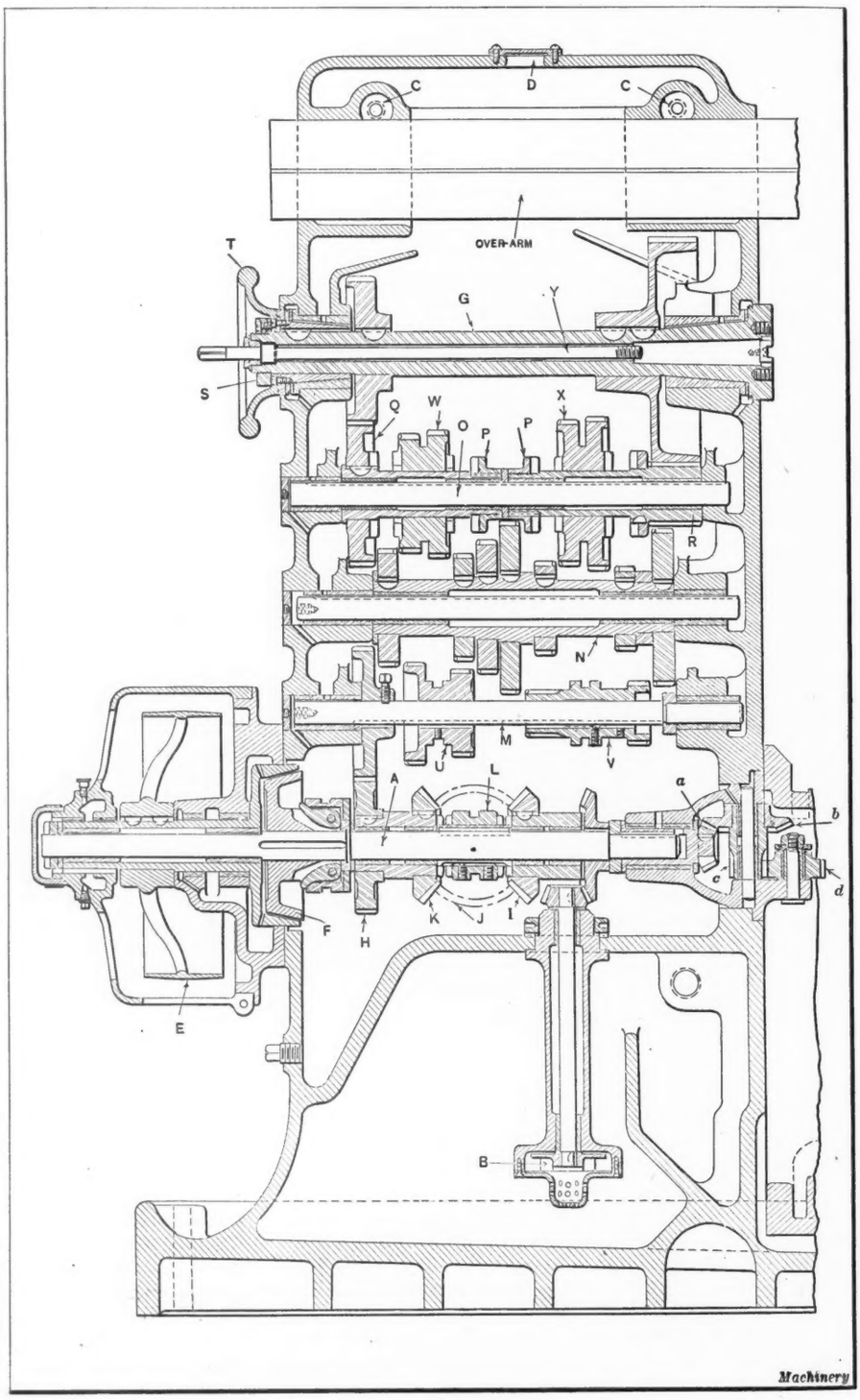


Fig. 1. Cross-sectional View of Column of Cleveland Milling Machine, showing the Main Drive and the Drive to the Spindle and Centrifugal Pump

gears which are connected by either of sliding gears *I* or *J* and which drive gear *K* mounted on a sleeve on shaft *L*. Power from gear *K* is transmitted to gear *H* by engaging the teeth of clutch *M* with those of the clutch member mounted on shaft *L* adjacent to gear *K*. Gear *H* drives its mating bevel gear *V* on the top of the elevating screw *N*. The threads of this screw engage those of nut *O* which is held in a post mounted on the base and is automatically lubricated. The knee is raised or lowered according to the direction in which the screw is rotated. The main knee casting has a bearing on the post in which the screw nut is mounted. Gear *V* has teeth on the upper side as well as on the lower, the upper teeth meshing with a pinion that may be rotated by hand by turning crank *B*, Fig. 3, when the power feed is disengaged.

Saddle and Table Feeds

Sixteen feeds to the saddle and table in geometrical progression are provided through the change-gearing in the knee; these are obtained by operating handles on the front of the knee as shown at *C* in Fig. 3. The saddle is adjustable on a dovetail slide on the knee, and is fed across the knee by means of a screw engaging a nut cast integral with the saddle, the screw being driven direct through the gearing in the knee or turned by hand when handle *Q*, Fig. 2, is revolved. This handle is applied to the square end of the screw which is located as shown at *D*, Fig. 3. The clutch for the power feed is operated by a handle on the right-hand side of the knee. Automatic operation of this clutch is also provided to stop movements of the saddle at predetermined points. The crank for feeding the saddle by hand is disengaged from the screw when this member is power-fed.

On the top surface of the saddle is mounted a swivel-head *R*, Fig. 2, and on the latter is mounted table *S*. The saddle and swivel-head are correctly assembled with reference to each other by means of a hardened annular ring which seats in a recess in the upper surface of the saddle and which furnishes a bearing for the head. Clamps are supplied to maintain the head in any desired angular position, and the base of the head is graduated to facilitate such settings. The drive from the feed-change gearing to the table is through a train of spur gears which drive shaft *P*, and then through bevel gears which connect shaft *P* to the table screw located at *W*. The vertical shaft *U* on which two of the bevel gears are mounted is located at the center about which head *R* swivels. The table screw engages a stationary nut on the swivel-head.

A clutch on the feed-screw engages and disengages the screw from the power drive. This clutch is actuated by lever *T* through a gear segment and forked lever. When the clutch is disengaged, the table may be hand-fed by revolving handwheel *E*, Fig. 3, or crank-handle *F*. The clutch can be disengaged automatically after the table has moved a desired amount, by an adjustable trip secured to the T-slot on the front side of the table, which strikes a projection on lever *T*, Fig. 2. The bevel gear on shaft *P* and those on shaft *U* are held in a bracket supported by the saddle, the gear on shaft *P* being free to slide so that it can follow the movements of the saddle. Easy traverse of the table is facilitated by means of rollers with which the swivel-head is equipped, and which keep the bearing surfaces amply lubricated.

Additional Features

Among the most important requirements of a milling machine are convenience and rapidity of operation, and in the Cleveland machine these are obtained by locating all control levers at the front and by having all mechanisms controlled either by a lever or a handle. The graduated dials provided on all adjusting screws are large in diameter. A rotary table can be mounted on the regular table, and in such an event the drive to the rotary table is supplied through an extension shaft and universal joints which connect this table to a train of gears on the right-hand end of the regular table, power being transmitted to this train of gears from the table feed mechanism. Although the machine illustrated is intended to be driven from a lineshaft by a constant-speed pulley, it may be arranged for motor drive in approximately two hours, the machine having been designed with this in view. A Morse silent chain transmits the power when the machine is driven by motor.

A machine equipped for cutting teeth in a rack is illustrated in Fig. 5. A special bracket *A* is attached to the face of the column, this bracket supporting a cutter-spindle at its outer end. This spindle is positioned at right angles to the machine spindle, and thus is parallel with the table, when this member is at right angles with the knee. The cutter-spindle of the rack attachment is driven from the machine spindle through spiral gears. A form cutter is used in cutting the rack teeth, and a tooth is produced each time the rack is fed transversely past the cutter by operating the saddle feed. After a tooth has been formed the rack is indexed longitudinally to suit the pitch through gearing *B* on the end of the table, which is connected to the table feed-screw. This gearing is actuated by operating handle *C* which has a plunger that engages a notch in a one-notch index-plate

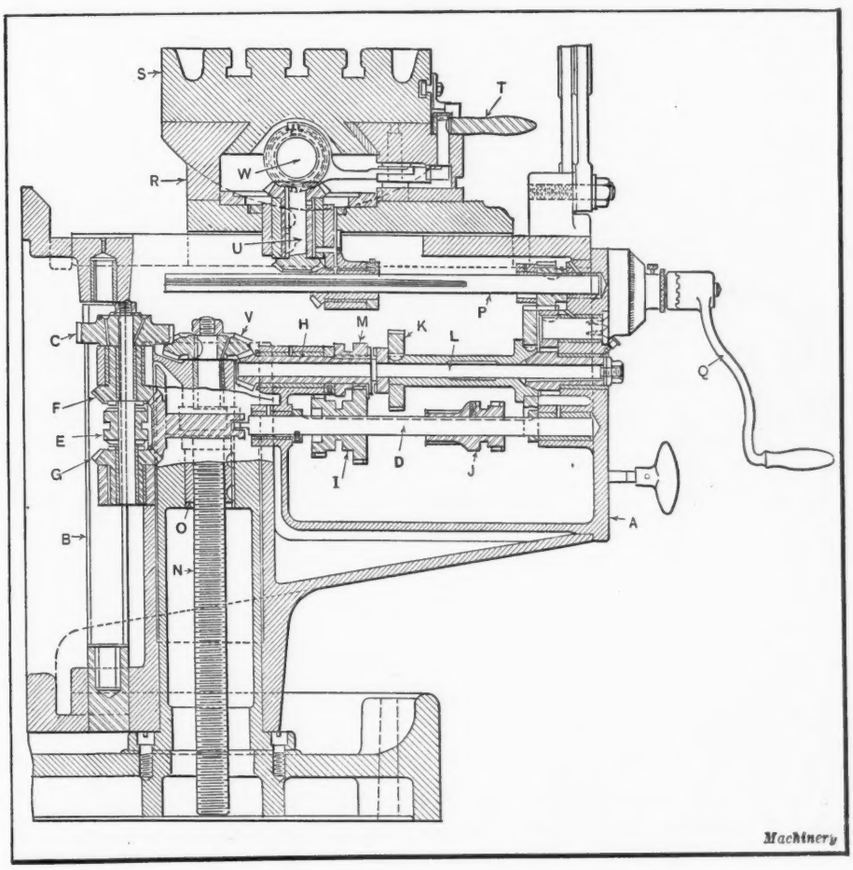


Fig. 2. Sectional View, showing the Important Mechanisms in the Knee

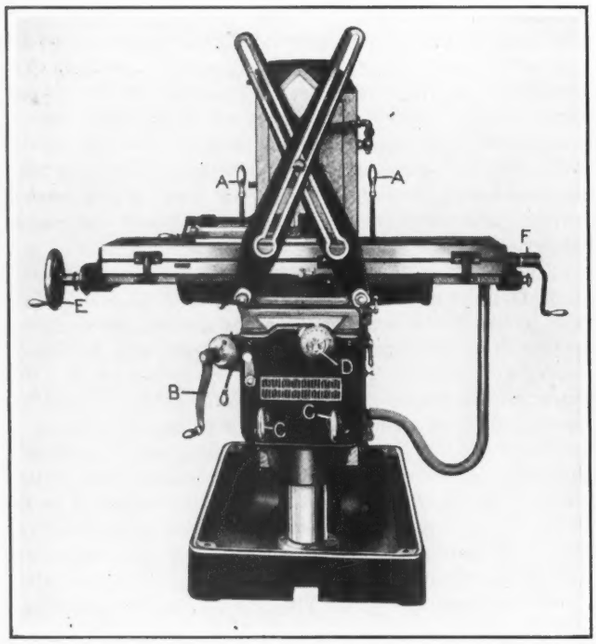


Fig. 3. Front View of the Machine, illustrating the Arrangement of the Arbor Supports

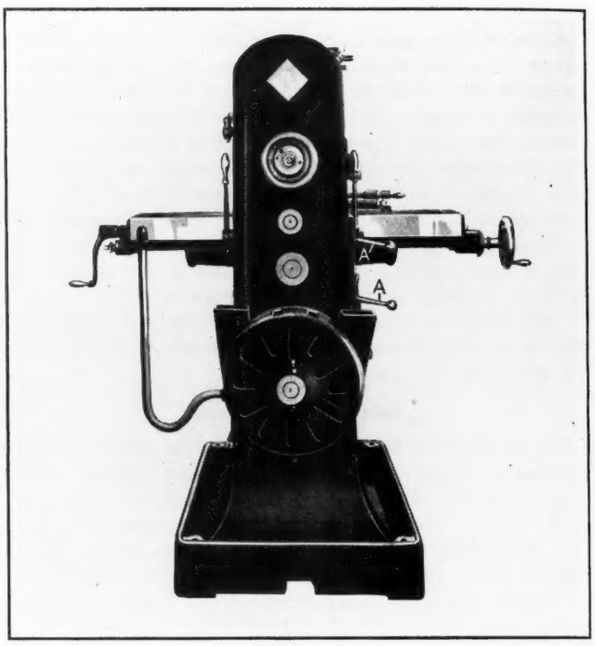


Fig. 4. Rear View of the Machine, showing the Bracket supporting the Driving Pulley

mounted on the same shaft as the top gear in the train. One movement of the handle causes the table and rack to be indexed the necessary amount.

Slotting Attachment

A slotting attachment may also be supplied to meet the requirements of diemakers and toolmakers and for use in shops where there is not sufficient work to justify the purchase of a regular slotting machine. This slotting attachment is firmly clamped to the dovetail slide of the column and located in position on the column by means of two pins at the top of the attachment base. The frame which carries the ram is graduated and can be swiveled through 180 degrees. This permits it to be used in the horizontal position without interfering with the stroke of the ram. The ram is of rectangular section and gibbed to provide adjustment for wear. Its stroke may be set for any length up to 4¾ inches. At the lower end of the ram is attached an adjustable tool-block made of hardened steel V-jaws, which will accommodate tools from ¾ to 1 inch in size. The drive to the crankshaft which actuates the ram is direct from the milling machine spindle through a coupling. Lubricant is supplied to the slide surfaces of the attachment by an oil-cup on the front of the ram and vees which convey the oil while the ram is in operation.

* * *

According to figures published in a recent Commerce Report, there were 558 plants in the United States in 1919 engaged in the manufacture of machine tools and metal-working machinery. The combined value of the products of these plants for that year was $248,573,000. The exports amounted to a value of $58,507,942, of which $22,627,477 represented machine tools.

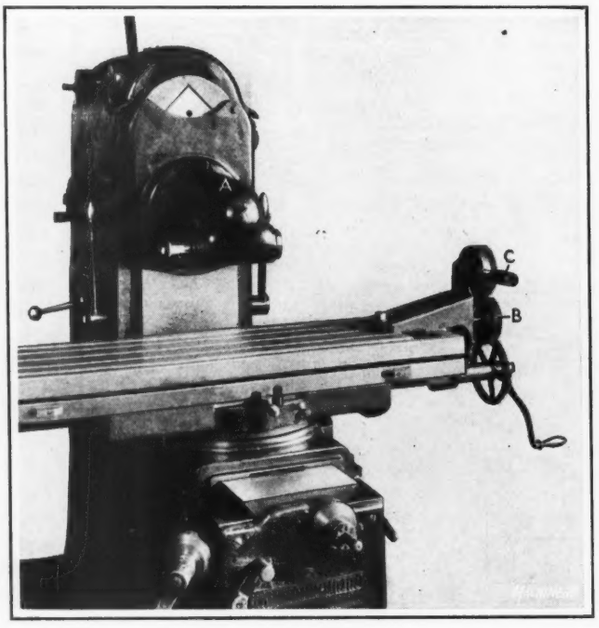


Fig. 5. Attachment for cutting Teeth in Racks

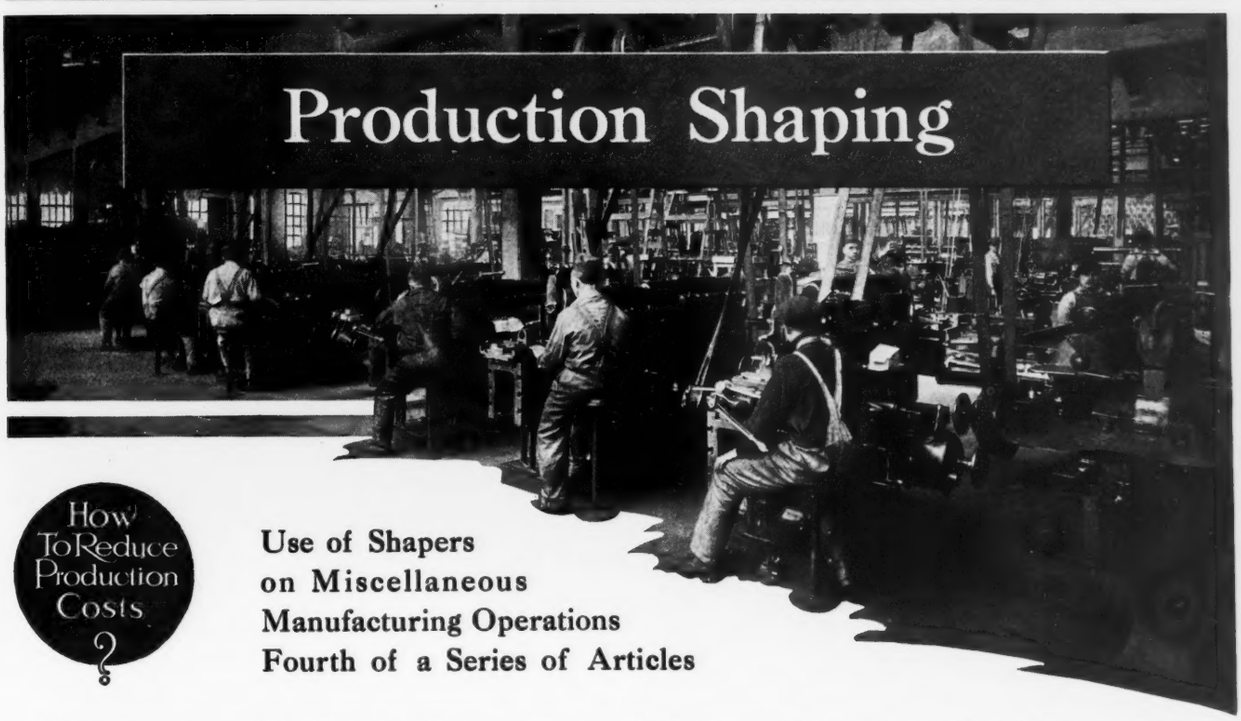
POLISHING FLUTES OF REAMERS

Flutes of reamers, taps, and other similar small tools are not usually polished in regular production work, but are ground with solid wheels. For this operation, according to *Grits and Grinds*, the Norton Co., Worcester, Mass., has found that alundum wheels 2 to 6 inches in diameter, by ¼ to ½ inch thick, grain 60 or 80, and grades O to Q, will give satisfactory results. Some manufacturers, however, polish the flutes of taps and reamers, and for this work a felt or leather wheel is generally used, unless the work is exceptionally large, when a canvas wheel is more satisfactory, since it will hold the abrasive better and give greater production. On the smaller sizes a leather wheel is considered best from the cutting standpoint, and it is also as good as other kinds for finish. Leather wheels are made from a good quality of oak tan leather, and they should be approximately 6 or 8 inches in diameter by ¼ or ½ inch thick.

Care should be taken to see that the polishing wheel is true, and if necessary it should be turned true before setting up with grain. When this is done, a sizing of good glue should be applied and left about two hours to dry. Then two coats of glue and abrasive are put on and left to dry over night. Before using, the grain on the sides of the wheel should be dressed off with a piece of broken grinding wheel.

The sizes of wheels and also the grain to use depend largely upon the sizes of the work to be polished. For large work a wheel of 60 or 80 grain will give good results, while for smaller sizes a wheel of about 120 or 150 grain is satisfactory. If a still better finish is required, grain 200 with Tripoli or oil can be used. This work is done free-hand.

Production Shaping



How To Reduce Production Costs ?

Use of Shapers on Miscellaneous Manufacturing Operations

Fourth of a Series of Articles

ALTHOUGH the principal field of application of shapers is in tool-room and experimental and repair shop work, machines of this type are now being used for many detail operations which must be performed in the manufacture of metal parts. For instance, one well-known maker of firearms has twenty-five crank shapers in the production departments of his plant, and this is but one of many examples that could be cited. The following article illustrates and describes the performance of miscellaneous manufacturing operations on the shaper, and will tend to emphasize the applicability of a machine of this type as a standard form of equipment for production work.

Application of the Tilting Table Flap for Shaping an Inclined Surface

Fig. 1 illustrates a typical application of the tilting table flap of the shaper built by the Potter & Johnston Machine Co., of Pawtucket, R. I. This construction provides for obtaining a specified angular relationship between the under surface of a piece of work that rests on the shaper table and the top surface that is being planed by the cutting tool. In this case, the piece to be machined is a cast-iron gear guard, the feet of which are bolted down to the table by means of clamping straps. By tilting the table flap, the top surface of the gear guard is finished at the required angle with the plane of the feet.

Use of Swiveling Table for Shaping Two Surfaces at an Angle with Each Other

Still another adjustment furnished on the Potter & Johnston shaper to provide for obtaining definite angular relationships between two surfaces of the work is illustrated in Fig. 2. The piece shown on the machine is a cast-iron bracket on which two surfaces are shaped at an obtuse angle to each other. The shaper table is carried on a pivotal support, so that after one surface has been finished, the table

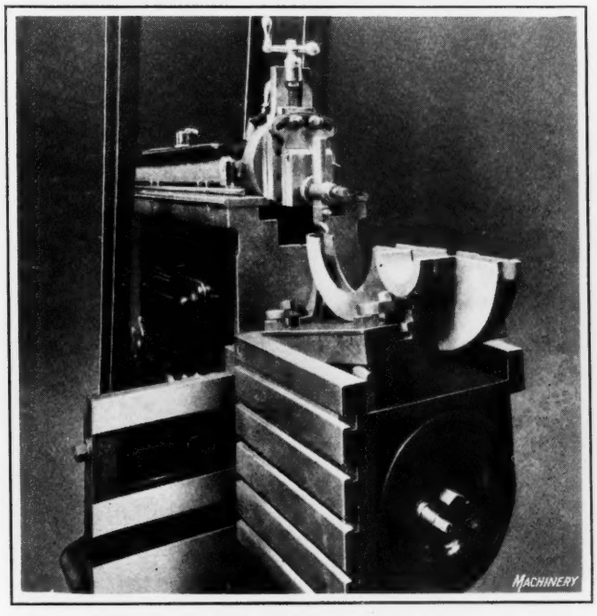


Fig. 1. Application of the Tilting Shaper Table Flap for obtaining a Specified Angular Relationship between Two Finished Surfaces on the Work

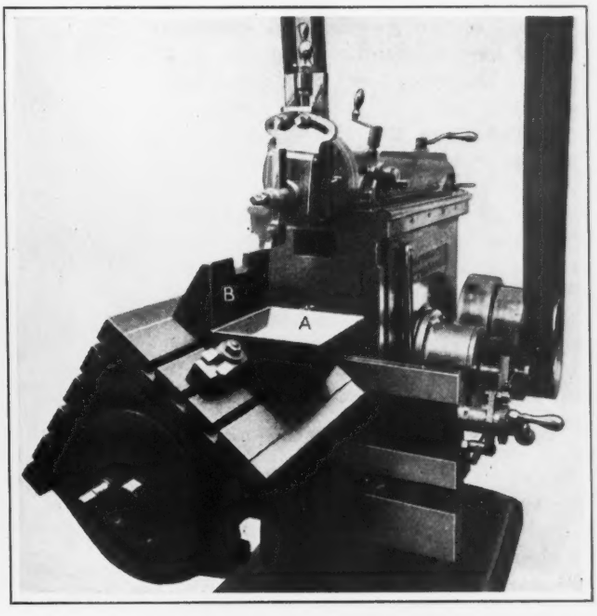


Fig. 2. Application of the Swiveling Table for obtaining a Definite Angular Relationship between Two Finished Surfaces on a Piece of Work

can be swiveled through any required angle for finishing a second surface at a specified angle to the one previously machined without resetting the work. In the present case, surface *A* was finished first, after which the table was swung over to the position shown for shaping surface *B* with a vertical downward feed of the tool. The shaper tool is forged with an offset in order to avoid any interference between the tool and the work. It will be seen that the casting is strapped down on the shaper table.

Shaping Both Sides of a Wide Slot Simultaneously

The piece of work illustrated on the machine in Fig. 3 is a sliding block used on a piston-turning machine. The operation consists of finishing the two vertical walls *A* of a wide slot, with a specified clearance between them, on a

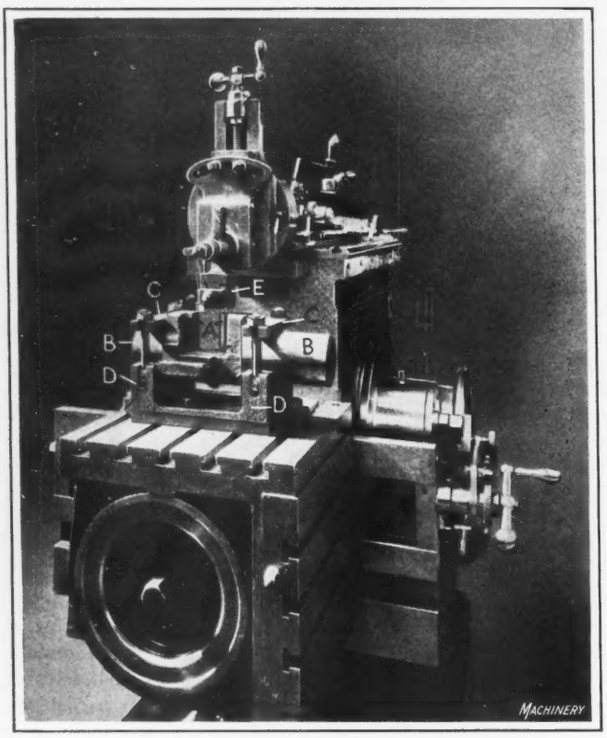


Fig. 3. Use of a Duplex Tool-holder for finishing Two Sides of a Wide Slot simultaneously

Potter & Johnston shaper. This job is interesting for two reasons. The two trunnions *B* have been turned before the piece comes to the shaper, and they are utilized as locating points by having a V-block fixture bolted to the table with straps *C*, which hold the trunnions down in the vees *D*. With the work located in this way, the two sides *A* of the slot are finished simultaneously by means of a tool-holder *E* that supports two cutter bits extending in opposite directions. The slots in which these bits are carried in the tool-holder, are inclined sufficiently so that the points of the tools will operate without interference between the tool-holder and the work.

Cutting Long Keyways on the Shaper

In cases where it is required to cut long keyways, or spline grooves, the shaper may often be employed advantageously. Such a case is shown in Fig. 4, where the shaft is held in a vise bolted to the table of a shaper built by the John Steptoe Co., of Cincinnati, Ohio. The work is done with a tool of the same width as the keyway or spline groove,

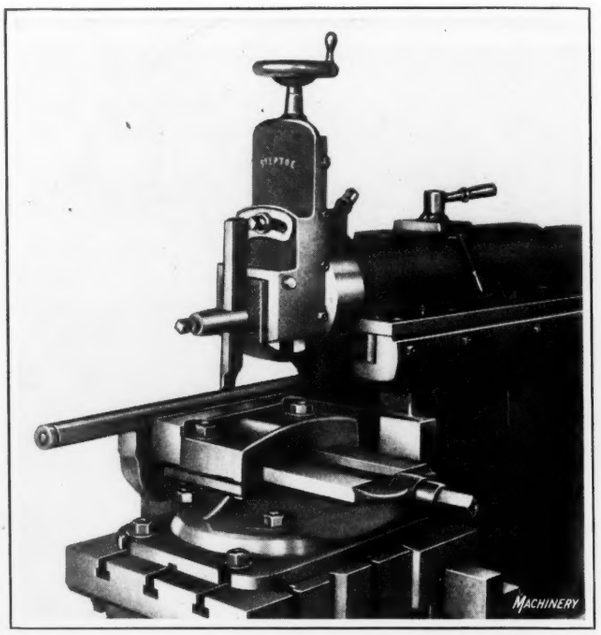


Fig. 4. How the Shaper is used for cutting a Long Keyseat

the latter being produced by feeding the work up to the tool until the groove has been sunk into the work to the required depth. If an exceptionally smooth finish is required on the sides, it may be found desirable to take a second cut with a slightly wider tool.

Many men of experience in the planning of machining operations would regard this as a job for which the milling machine would be peculiarly well adapted. Local conditions would naturally affect the results that could be obtained, but on either type of machine the setting up time would be approximately the same, and it is probable that there would be little difference between the actual time required to form the groove with either a milling cutter or a shaping tool.

Shaping Wobbler Rolls

An interesting operation showing the application of shapers on work other than machine tool parts is illustrated in Fig. 5, which is a close-up view of one end of a very heavy steel wobbler roll on which it was necessary to plane the semicircular grooves that are used for driving

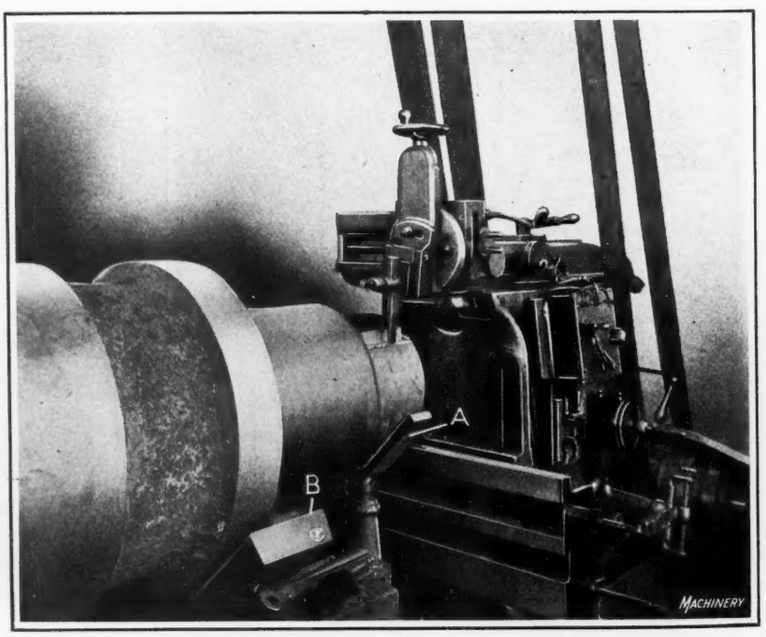


Fig. 5. How a Traverse-head Shaper is used for cutting Integral Key

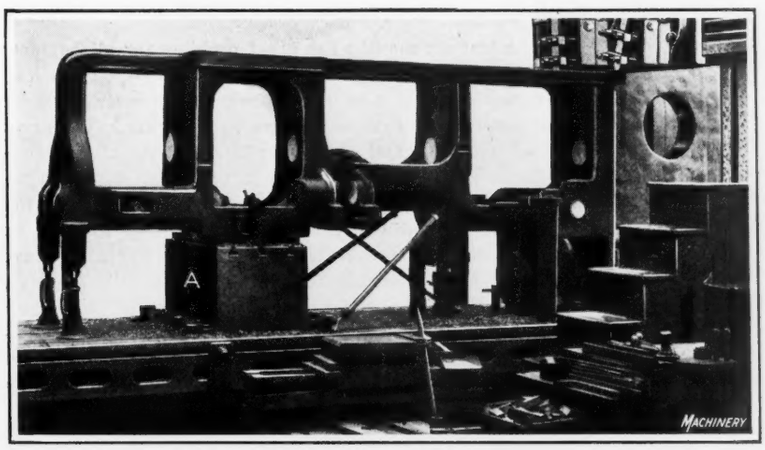


Fig. 1. Automatic Screw Machine Frame Casting set up for planing

the roll. The operation is practically impossible to perform except by using a shaper that is adapted for this work. In this particular instance, the roll was brought to the machine by a crane and set in the proper position with the inner end supported by a cradle *A*, which is mounted on an adjustable jack to locate the work. The cross-rail and table of the shaper were removed as will be seen in the illustration.

The shaper is provided with a traverse head having automatic horizontal and vertical feeds similar to a planer, and has sufficient adjustment to make it possible to plane the wobbler grooves without difficulty and in much less time than by any other method. In some shops where motor-driven shapers are used, it is found easier to transport the shaper to the work on account of the great weight of some of these rolls.

* * *

PLANING OPERATIONS ON PARTS OF NATIONAL ACME AUTOMATICS

Figs. 1 and 2 show the set-up of the frame casting for a National Acme multiple-spindle automatic screw machine on a Cincinnati planer. It will be seen that the casting is of rather unusual size and of such a shape that there would be considerable danger of distorting it by the pressure of the planing tools, unless adequate precautions were taken to avoid such trouble. Before starting to set up the casting, each of the bosses in which shaft bearings are subsequently to be fitted, has been carefully laid out, so that these fixed points on the work may be used in setting the planing tools, thus making sure not only that all planed surfaces on the casting will be properly cleaned, but also that these faces will be correctly located relative to the other fixed points.

The casting is first located by means of a supporting block *A*, which is secured to the table of the planer. This block is employed when the casting is inverted for planing the base; when standing on its own base, no special support of this kind is required, because there is a uniform flat face for the casting to rest on. However, regardless of whether the work is standing right side up or upside down, there are numerous points at which it is necessary to provide additional support to prevent springing the casting out of shape under the pressure of the cut; this is accomplished by the use of jacks, as shown in the illustrations. Adequate support is furnished by this means, and by the use of end-stops, straps, and packings usually employed in the performance of planing operations.

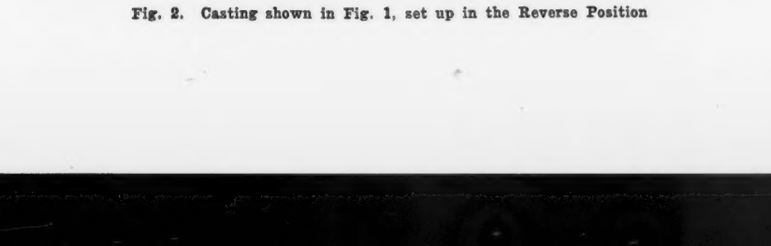


Fig. 2. Casting shown in Fig. 1, set up in the Reverse Position

Planing the Dovetailed Bearing in a Cross-slide Block

In Fig. 3 a finished cross-slide block for a National Acme automatic screw machine is shown at *A*, and this illustration also shows the way in which a string of these castings is set up on a G. A. Gray planer for planing one of the dovetailed bearings of these blocks. The castings are clamped against a parallel bar fixture by means of bolts and fingers. Sheet-metal guards *B* are placed over the ends of the clamping fingers to protect

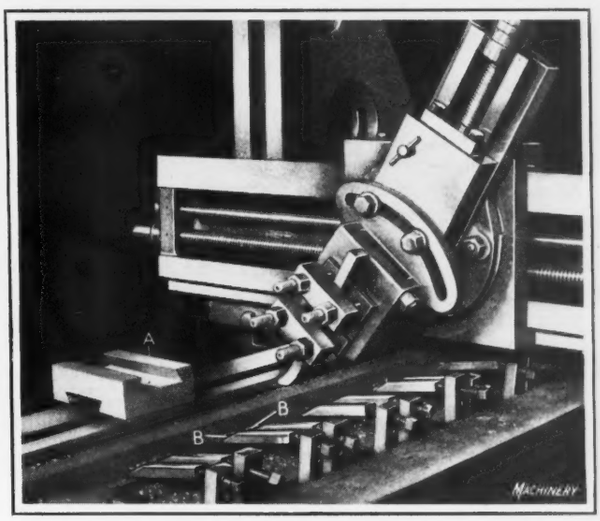


Fig. 3. Planing Dovetailed Bearing in Cross-slide Blocks for National Acme Automatics

the finished surface of the work. In this operation, the point of interest is the provision which is made for finishing the angular under-cuts of the dovetailed bearings. This is accomplished by setting the tool-head at an angle so that the tool point can be fed down the inclined side of the work. The tool is forged with an offset point which enables it to operate without interference between the side of the tool and the work. In performing this operation, the method of procedure is to first cut a slot of rectangular cross-section, and then to perform the under-cutting operation as shown. The material is cast iron, and this job is performed with a feed of 1/64 inch per table stroke and a cutting speed of 36 feet per minute.

* * *

Great improvements are being effected in the French railway system, according to an item in a recent Commerce Report, and the rolling stock now includes about 1000 locomotives and 50,000 cars more than before the war. Traffic has increased, and 40,000 cars, on an average, were loaded daily during September.

HOW THE MACHINE TOOL SALESMAN CAN SERVE THE INDUSTRY

By a Machine Tool Sales Manager

Rumors—good, bad, and indifferent—surge through all industries. Some of them are based on facts, many are not. At the present time there is a rumor circulating in many industries to the effect that manufacturers are trying to meet the demand for lower prices by lowering the quality of their products. It is impossible either to confirm or contradict this rumor, in so far as it concerns *all* the different industries of the country; but it is a matter of great consequence if such a rumor should be circulated in regard to the machine-building industries in general, and the machine tool industry in particular. Whether such rumors invade the industry and are allowed to circulate depends largely upon the viewpoint and activity of the salesman.

With all due credit to the efforts of catalogue and trade-paper advertising to create quality ideas in the minds of the buyers, it is the spoken word of the salesman that leaves the lasting impression. The machine tool salesman, of course, will always say that the particular machines that he represents have greatly improved; but he sometimes implies that the machines of his firm are the only ones about which this could be said. Then he is followed by another salesman who represents another machine, which is the "only exception." There can be only one effect upon buyers of such an attitude. The impression is created that there must be some ground for the untrue rumors, and this will prove injurious to the industry.

No salesman would want to plant favorable impressions which are likely to grow into orders for his competitors, but he should never forget that his firm is part of his competitors' industry, and that no permanent gain can be made by reflecting unfavorably in any way upon that industry. Suppose that he is selling lathes. He will make a much stronger impression by admitting that all lathes have made rapid progress within the last few years. They are all improving, for the machine tool industry can never stand still, and his own firm had to hustle to keep their usual place in the lead. To hold their lead they secured the best engineers and made improvement after improvement. It is true that another salesman will come along with another leading lathe, but is it not better to have several claiming to be the best builder, instead of having all condemn every machine except their own?

The Old-time Shop Mechanic

In one respect machine shop mechanics are like ball players of bygone days. Just as the old ball player likes to tell how much faster the old game used to be played, so the old-time mechanic likes to praise old-time workmanship, and tell how certain old-time machines "made as they used to make 'em" were better than those made today. This is a pitfall which the machine tool salesman must take care to avoid in these times. It would be easy at the present time to help spread the thought that machine tool workmanship really has not improved, or having improved, is now yielding to a different tendency. Yet, if the salesman permits himself to agree with these statements, he is showing himself ignorant of the remarkable advance of recent years, and by ignoring well-known facts is doing a great injury to the industry in which he is engaged.

It is true that machine tools have always been built with a great deal more care than a great many other lines of machinery, and old-time machines have some very good workmanship. But today the gears are made of steel—perhaps hardened steel or alloy steel—many of the parts are ground to size, and modern measuring tools have reduced the working limits and made perfect alignment the rule, whereas formerly it was an exception. The machines of today are heavier, they have more power, and they perform more and better work.

The Question of Lower Prices

For the last six months the great problem for all business men has been to establish confidence in business, and it may be said that this has been accomplished. As individuals we are all determined that prices are to be lower. We know that food, clothing, and other standard articles of consumption should and will come down in price, but for such articles there is generally a standard of quality, which for the same classes of goods is the same today as it was ten or twenty years ago. In the machine tool industry a different condition exists. Machine tools will continue to improve, and the machine tool salesman should impress that upon the minds of his customers. It is doubtful if there is another industry in which quantity is as subordinate to quality as in machine tool building. The first thing that is demanded of a machine tool is quality. The prices of machine tools will never recede to the pre-war levels, because of the improvements that have been made both in design and workmanship during recent years. The machine tool salesman who casts a reflection upon the workmanship of the product of any reputable machine tool builders whose products may compete with his is doing an injustice to the entire machine tool building industry.

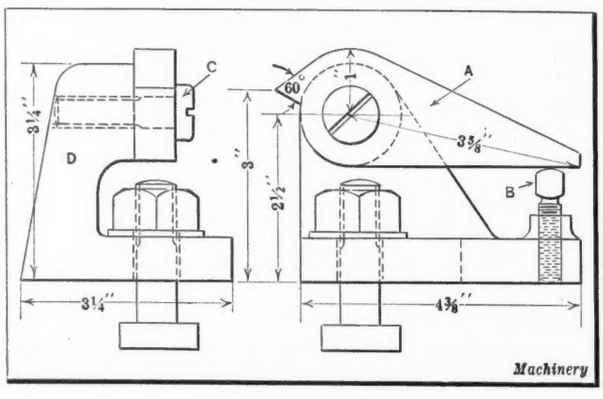
The best service that the machine tool salesman can render today is to give useful and accurate information as to the products of the entire industry. The impressions that he allows to remain in a prospective customer's mind will be passed on to others, and he should check any impressions that may create an unfavorable opinion of the industry.

* * *

CLAMP FOR PLANER WORK

By JOE V. ROMIG

A clamp or pinch-dog, which is intended for holding flat work on a planer table, is shown in the accompanying illustration. It will be noted that the 60-degree tooth of the clamping member *A* lies in a higher plane than the axis of the bolt *C*. When in use, the body *D* is clamped to the table in such a position that the 60-degree tooth of clamp *A* will be in contact with the side of the work. When screw *B* is elevated, a downward and inward pressure is exerted on



Clamp for Planer Work

the work by the point of the 60-degree tooth. In some cases it is advisable to cut a shallow notch in the work with a chisel for the reception of the clamping tooth. When used on work having finished surfaces, a smooth block of metal is placed between the tooth of the dog and the work.

It is obvious that clamps of this type are intended to be used in pairs, so that a clamp on one side of the work will be located directly opposite a similar clamp on the other side. The clamping-bolt slot in the base of the fixture is long enough to permit the dog to be attached to the planer table in almost any position. The device can be located on parallels in order to obtain the desired clamping action on high work. The body *D* may be made of cast iron, and the clamping member *A* of hardened and drawn tool steel.

Feeds and Speeds as Production Factors

By ALBERT A. DOWD, President, and FRANK W. CURTIS, Chief Engineer, Dowd Engineering Co., New York City

How To Reduce Production Costs ?

ALL manufacturers agree that correct cutting speeds and feeds of machines are essential to maximum production, but there are comparatively few who give the matter sufficient consideration. If the production and the establishment are large, the little losses here and there due to incorrect speeds and feeds may make a total loss of thousands of dollars in the course of a year, and even in a small factory, the loss in production will result in a considerable loss in money. Manufacturers often do not make any great effort to keep machines up to their maximum output, because it is thought that the changes necessary may interrupt production and cause a still greater loss. Also, past experiences in changing feeds or speeds may not have proved successful, due to the poor judgment of the man engaged on the work.

Importance of Recording Speeds and Feeds

There is in all probability no more important factor in production work than the use of correct feeds and speeds, and yet, admitting that each manufacturer wishes to keep his machines running at 100 per cent efficiency, he is not always willing to take the proper steps to insure such a condition. A lathe may be turning a piece of work at too slow a speed and a request may come from the foreman of the department to install a larger pulley on the lineshaft in order to obtain the desired increase of speed. A similar job may be in process in another part of the factory at a different speed and feed without the foreman knowing about it, because he has no supervision in the other department. He may not even know the correct speed at which the work should be revolved to insure the greatest efficiency, but realizes that the production is not what it should be.

An occurrence like this reveals the importance of keeping a record of machine speeds and feeds employed throughout the entire shop and those used on every piece of work which has been made. With a carefully kept record and proper supervision of the machines to see that they are producing as they should, there is no reason why one lot of parts being machined today, should be produced at a slower rate than another lot of the same kind made several months ago. In addition to this, there is always the possibility that production can be increased more or less if the man in charge of setting feeds and speeds conscientiously does all he can to obtain the highest production. This brings us to an important point in the discussion—the selection of a competent man to set all speeds and feeds.

Selection of the Right Man to Set Speeds and Feeds

In determining a man's qualifications for the position, a number of matters must be taken into consideration in order that no mistake will be made by picking out a person likely to use poor judgment or antagonize the department foremen. Mechanical knowledge over a broad field is an essential item, and this knowledge should be of a thoroughly practical nature gained not only by actual shop practice but also by study and analysis. A clear-thinking man having a critical turn of mind, yet not hasty or of the egotistical type, will usually be found to be best for this kind of position. Another essential quality is the ability to determine whether a machine is at fault in not giving sufficient production or whether the loss is due to castings being too hard, or other conditions. In a shop of normal size, one man should have charge of all speeds and feeds, and none of these should be changed in any department without a written order from him. Naturally, this could not apply at first, as it would interrupt production and cause a great amount of trouble.

Installing a System of Recording Speeds and Feeds

In the installation of a system of this kind, the first step would be to make a list of all machines with complete data regarding speeds and feeds for each, their location in the factory, their factory number, etc. Much of this information should be easy of access through the tool engineer, other heads of departments, and factory records. It is advisable to file record cards according either to the type of machine or the department, as may be found most suitable for ready reference. A card suitable for this kind of record is shown in Fig. 1. If a machine is kept continually on a given piece of work, it may be found more convenient to incorporate all data about the speeds, feeds, and rate of production on the card record of the machine. However, as the majority of factories use machines on more than one piece of work, a record of each piece with the details of each operation may be found more useful. A great deal depends upon conditions in the factory, and the system should be devised according to their requirements.

Fig. 2 shows a card which can be used to record facts about the work itself, such as the machine on which a given operation is performed, the speed and feed used, and the rate of production obtained. A single card should be used for each operation, and complete details regarding the production should be given in such a form that it will serve

NAME Cincinnati Miller TYPE No. 1M Plain
FACTORY NO. 1430 BUILDING # 8 DEPT. # 14

SPEEDS—R.P.M.	FEEDS	CAPACITY
20-27-35-46-61	1/2" to 20" Per	22" Longitudinal
82-102-137-183	Minute - 12	8 Cross - 19 Vertical
234-316-419	Changes	with dividing head 17
		between centers-20 diam.

REMARKS Table 37X10½-3 T-slots # 14
B. & S. Taper. - This machine completely overhauled 4-17-21

Machinery

Fig. 1. Card for keeping Data Relative to Machine Tools, such as Speeds, Feeds, and Capacity

PART 188 Bearing Bracket
OPER. 3 Rough-turn hub diameter
DEPT. 100 MACHINE 14" Engine Lathe
SPEED-R.P.M. 182
FEED PER REV. 0.016"
PRODUCTION 320 Pcs. per 8 hours
REMARKS This operation was increased to above speed 5-23-21 after changing design of turning tool. Old Speed was 155 R.P.M.

Machinery

Fig. 2. Work Record Card which gives Machine Tool used, Speed and Feed, and Production Rate

CHART SHOWING CONDITIONS WHICH GOVERN SPEEDS AND FEEDS

Machine Tool	Size: Heavy or Light Condition: Good or Bad Style: Old or New Right Machine for Nature of Cut
Material	Annealed, Hard, Medium, Soft Too Much Stock to Remove Shape of Work Proper Heat-treatment
Tool Used	Grade: Steel, Stellite Properly Ground Properly Held and Supported Properly Hardened Size: Large Enough to Carry off Heat Number of Pieces per Grind
Lubricant	Necessary or Not Composition Flowing Correctly Flow Large Enough

as a guide in setting up the machine and operating it when the same work is again placed in the shop. After these cards have been prepared, shop tests can be instituted gradually, each machine being tested according to the work it is doing in order to be sure that this is being accomplished in the best manner and in the least possible time. When making the tests a record should be kept of the old and new speeds and the resulting gain in production. Such records will be found of great value, as they not only show the gain in production, but also the method used to obtain the result. If the same job is put through the factory at intervals any deviation from the standard time originally set should be accounted for.

Factors to be Considered in Setting Speeds and Feeds

In analyzing the conditions that affect the setting of speeds and feeds, it will be found that the four following factors are particularly important: the machine tool used for the operation, the material to be cut, the cutting tools employed, and the lubricant used. Each of these factors should be carefully considered from several angles, and as any one of them often affects the others, the engineer should consider the problem in general in connection with each factor, if best results are to be obtained. The accompanying chart will assist a man new to the work to reach a decision regarding the various essential points. The order in which the different factors are mentioned is the logical sequence for a rapid analysis of conditions, although it is possible to start at almost any point, provided certain requirements are known to be correct.

Machine Tools—The machine tool for a given piece of work should be selected with care to make sure not only that it is the ideal type for the work, but also that it is in good condition. High production with the necessary accuracy cannot be obtained unless the equipment is in first-class shape, and a great deal of trouble is caused by an attempt to turn out a high-grade product with inefficient equipment. Modern machine tools are to be preferred to the older types for several reasons: They are more convenient to operate, and have more power and greater range; hence, they will turn out work more rapidly and with greater precision. The man in charge of speeds and feeds should recommend the substitution of newer types of machines for those which are obsolete and which, as a consequence of their condition, cause production to fall below normal.

Material to be Cut—After the machine tool selected for an operation has been found to be in suitable condition to perform its part of the work, the material to be machined should be considered. Steel, cast iron, and brass should not be cut at the same speed and feed. Cast iron may be chilled, hard, medium or soft, all of which conditions require a different rate of speed and feed. So also brass and aluminum vary in their composition and must be cut at suitable speeds and feeds. Tests should be made of the material to be cut, and if found far from normal it should be returned to the foundry or forge shop for proper treatment. If work comes through the factory with some pieces hard, others medium, and some soft, a machine cannot be expected to turn out a uniform product at established rates of speed and feed.

Certain kinds of material can only be brought into a uniform condition by annealing, and when this is the case care must be taken to see that the work is thus treated before it is placed in production. On some classes of work it may be found that the finish allowance is too great and that it would be better to change the pattern so that the cutting action will be less severe. The shape of the work also has some effect on the speeds and feeds which can safely be used, as a part which is very thin and fragile or one on which the cutting action is interrupted, will not permit the same speeds and feeds that might otherwise be employed.

Cutting Tools and Lubricant—The next step is to note carefully the cutting tools and lubricant used. These two items are shown separately on the chart, but they may often be considered together. Sometimes a heavier tool or one made from different material will result in an increase in production; for example, a stellite tool may be substituted for one of high-speed steel with an appreciable gain in production, although stellite would not always be found entirely suitable. On certain classes of materials and kinds of cutting, substantial gains can be made by the use of the tool best suited to the work. The length of time which a tool will run without grinding is a fairly reliable guide as to whether it is suited to its work or not; however, the most economical tool is not always that which stands up the longest, as it may be better to grind it several times a day if an increase in production will result. A common lathe tool, for example, may reasonably be expected to require regrinding oftener than a form cutter, which would perhaps need a special attachment in order to grind it properly. The latter may also require considerable time for setting up, while the former can be located and clamped readily.

A heavy tool carries away heat from the cutting point more rapidly than a light one; hence it is used where heavy cutting is required. The use of various kinds of lubricants often shows that a tool will stand up longer with one than with the other, and when this is the case, it is obviously more economical to use the compound which shows the greatest efficiency. In cutting threads, for instance, oil gives better results than soda water or other compounds. Some materials can be cut wet or dry, but usually one method is better than the other, and whichever it is, it should be used if circumstances will permit. A lubricant serves two purposes—it reduces the friction and cools the tool. Both of these functions should be considered in selecting a lubricant.

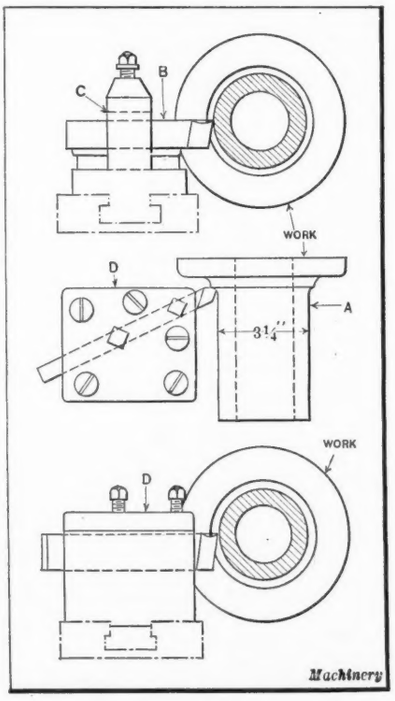


Fig. 3. Job on which Savings were effected by altering the Design of the Toolpost

Setting the Speeds and Feeds

After a number of tests have been made on different classes of work and kinds of materials, it will be found an advantage to make up tables of the results so that they can be used in the future for setting speeds and feeds on new work. It is essential to have these tables in such shape that they can be referred to readily; therefore, a cross-index which refers to a number of actual tests on cast iron, steel, brass, etc., is of value in connection with the tables. A great many points regarding speeds and feeds have been mentioned in order to bring out their value in relation to the general subject. We could easily go a step further and state that cast iron can be cut at a surface speed of 50 feet per minute, mild steel at 80 feet, and brass and aluminum at 200 feet, but such information would serve no useful purpose except to give an approximation of what can be accomplished under normal conditions, and we should then be obliged to determine what a normal condition is.

Cutting speeds for various materials can be found in any mechanical handbook, but any kind of rule of this sort must be flexible. Cast iron may be cut at speeds ranging from 30 to 150 feet per minute, depending on the quality of the material, depth of cut, finish desired, tool used, feed of machine, and other matters which have been mentioned. Other metals and alloys can also be cut at widely different rates of speed and feed, depending on the circumstances. The proper cutting speeds and feeds for a given piece of work are those which will produce it within the required limits in the shortest possible time and what these speeds and feeds should be must be determined to a great extent by tests and by the most careful supervision. The maximum speeds and feeds cannot be obtained by calculation, although comparative records are a great help in this connection. The highest and best production is obtained through a capable man who is always in the shop and who is never satisfied with results until assured that the limit has been reached.

Savings made Possible by Increasing Rate of Feed on a Lathe

A few specific examples of actual savings effected by giving attention to the speeds and feeds of machines will illustrate the value of proper supervision of this work. Fig. 3 shows a flanged cast-iron piece *A*, which is finished in a turret lathe, the flanged portion being held in chuck jaws. Tool *B* is used for turning the cylindrical surface of the piece, the length of the cut being 5 inches. The original method of holding the tool was by means of a standard tool-post *C*, and the depth of the cut was 1/16 inch, the feed 0.020 inch per revolution, and the speed 50 feet per minute. The length of time needed to make the cut was 4.54 minutes.

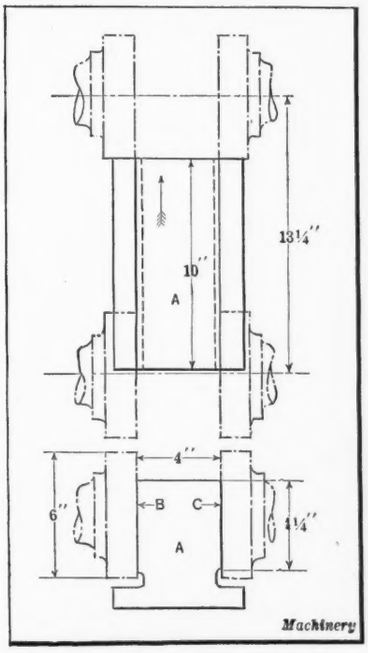


Fig. 4. Job on which a Reduced Speed and Increased Feed aided Production

The foreman of the department considered this satisfactory, as he had found that a coarser feed produced chatter, but the man in charge of the speeds and feeds considered the time too slow. In tests he tried a speed of 65 feet per minute, with the result that there was considerable chatter and the tool was soon ruined. He then decided that the method of holding the tool was largely responsible, as it was not suited to withstand heavy cutting, and so, a heavy special tool-post *D* was made which permitted a heavier feed to be taken without appreciable vibration. Now, a speed of 50 feet per minute is employed and a feed double that previously possible, or 0.040 inch per revolution. By this means, the time of the cut has been reduced to 2.27 minutes. The time required to make the change was thirty minutes.

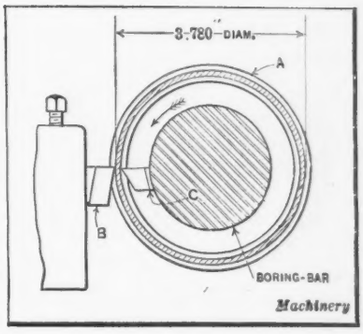


Fig. 5. Example in which Stellite Tools were substituted for High-speed Tools

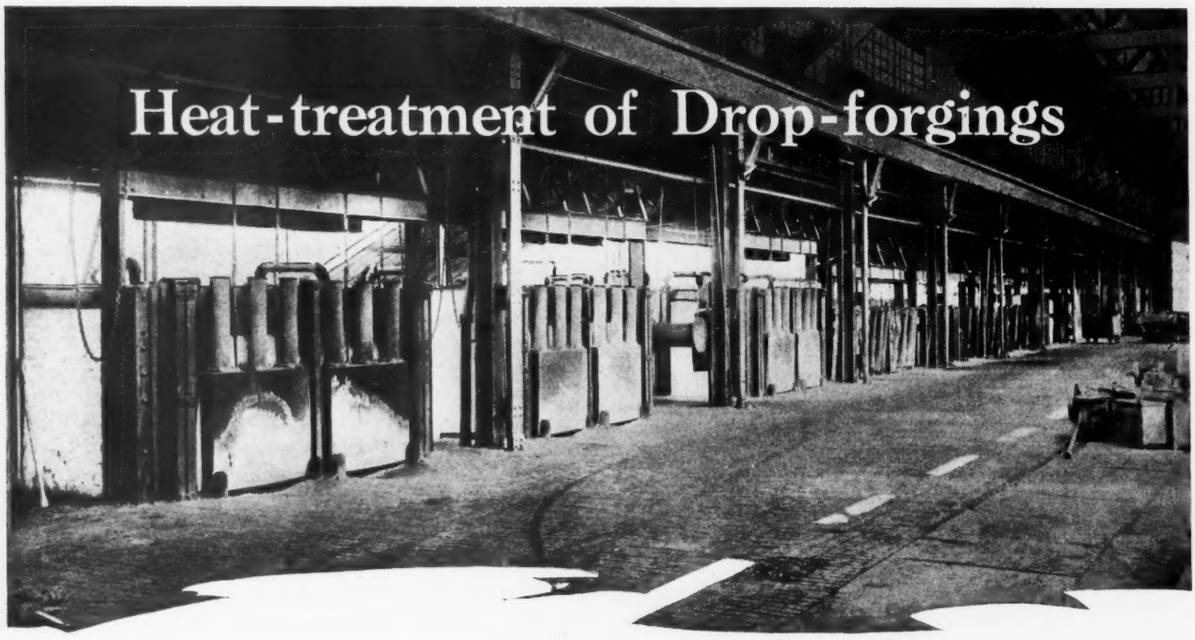
Increasing Production on a Milling Job by Reducing Speed and Increasing Feed

Another example is presented by Fig. 4 which shows a steel billet *A* that is face-milled on two sides *B* and *C*. The amount of stock removed is 3/32 inch on each side; the length to be cut, 10 inches; the total traverse of the table, 13¼ inches; and the diameter of the cutters, 6 inches. The original speed of the cutters was 80 feet per minute, the table feed 0.100 inch per cutter revolution, and the time required for the cut 2.55 minutes. It was decided that the cutting speed was too great, as the cutters did not stand up as they should. Therefore, their speed was reduced to 60 feet per minute, and the table feed increased to 0.200 inch per revolution. The new time of production was 1.65 minutes, and the cutters kept sharp a much longer time. This example illustrates the savings possible in milling operations by a judicious selection of feeds and speeds. Generally slow speeds and coarse feeds are better for milling operations, but this is not always so. Chatter in milling may often be remedied by a suitable change in feed or speed or both. A little experimenting along these lines will prove of value, as chatter is fatal to good workmanship, and causes loss in production and injury to the tool equipment and the machine.

Savings Effected by a Change in Tools

Occasionally more suitable speeds and feeds can be set for a job by changing the tool or its general shape. This matter, however, should be approached with caution, and unless an analysis determines conclusively that the tool is at fault, it would not be found advantageous to change it. Fig. 5 shows a ring pot *A* that is simultaneously turned eccentric by tool *B* and bored by tool *C*. Both of these tools were formerly made of high-speed steel, but they did not stand up well on account of the hardness of the material. On an average only six pieces could be turned and bored before regrinding of the tools was necessary. The speed of the work was 37.1 feet per minute, the feed was 0.035 inch per revolution and the production per eight hours was 65 pieces. Some of these would not pass the inspector on account of the tools being slightly dull and, therefore, not producing the work within the required limits.

Stellite tools were substituted for the others, and the speed was increased to 39.6 feet per minute and the feed to 0.042 inch per revolution, with the result that the tools machined 140 pieces before regrinding was required. The production increased to 89 pieces per eight-hour day, the gain amounting to 36.9 per cent. From this example it is plain that a change in a tool may increase production in some cases. The great variety of conditions encountered make it impossible to give hard and fast rules for this kind of work, but great gains can be made if care is taken in the selection of the right man for the work, giving him the authority to make necessary changes in feeds and speeds and, in this way, making him solely responsible for the work throughout the factory.



Heat-treatment of Drop-forgings

Furnace Design and Fuels Suitable for Treating Drop-forgings

IN the articles published in November and December MACHINERY, a number of examples of modern drop-forging practice were illustrated and described, together with the dies used in producing them. In the present article, the practice followed in heat-treating drop-forgings and the equipment employed will be discussed, with special reference to furnace design and kinds of fuels commonly used.

As a general statement it may be said that annealing will improve the reliability of any forging, although it is not necessary to anneal all forgings; in fact, there are a great many that are never annealed and that give satisfactory service without such treatment. As a rule, small parts need not be annealed except, perhaps, to make them easier to machine. Low-carbon steel parts that are to be casehardened should first be annealed to overcome the tendency of the forgings to warp during the casehardening process. If they are not to be casehardened, straight carbon steel forgings of not more than 0.30 per cent carbon are rarely annealed unless by so doing subsequent machining will be facilitated.

Complications have arisen in connection with the heat-treating of steels during recent years due to the ever-increasing use of alloy steels of a great variety of compositions. These complications have been met by the advances which have been made in the metallurgical field, which have resulted in better control arrangements for the heat-treating department. The practice now followed in modern plants is to rely wholly on the directions issued by the metallurgist for handling steel in the furnace, and in quenching and tempering, to obtain the physical qualities desired in the finished forging.

When it comes to the actual heat-treating, it is necessary that the man in charge be capable and experienced in the operation of the furnaces, so that he can intelligently carry out the instructions of the metallurgical department. The human element enters into the process to a considerable extent, and hence the methods may vary somewhat from the recommendations of the technical expert. It is noticeable that rarely can two shops be found which carry out the identical heat-treating instructions in the same manner, which, of course, is due to the human element, and for this reason rather wide tolerances are permitted in the heat-treating specifications.

Fig. 1. Observing Conditions in Heat-treating Furnace

Refining the Grain Structure Preparatory to Hardening

As the steel leaves the hammer, the grain is large and it should be refined by annealing. Before dependable results can be assured, every precaution must be taken to obtain steel which will conform exactly to the specifications recommended by the metallurgical department for the particular service required. Working to specified temperatures is of little value unless the analysis of the steel is known. The temperatures for annealing and hardening and all data referring to the heat-treating of steel are furnished by the steel manufacturers in some cases, although the most satisfactory results are those obtained when the steel is made to the analysis furnished by the purchaser's metallurgist or chemical engineer.

The annealing process consists of heating the steel slowly and uniformly to a few degrees above the lower critical point (usually about 1600 degrees F.) and allowing it to cool without being unduly exposed to the atmosphere. This can be done either in the furnace or in suitable cooling pits. Perhaps the most satisfactory results will be obtained with the intermittent pusher type of annealing furnace. This is equipped with a mechanical device for intermittently advancing the plates on which the work rests into the heating chamber a few inches at a time. The heat in the chamber may be so regulated that as the work advances into the furnace it will be

subjected to a gradually increasing temperature, and as it approaches the discharge end of the furnace the temperature will gradually decrease. The temperature in the center of the chamber is, of course, the proper annealing heat. By this means absolute uniformity is assured, and as the work is delivered from the discharge end it is dropped into baskets or other suitable receptacles where it is left until it has cooled completely.

Treatment after Annealing

If the steels are of the straight carbon class, they should be heated, after annealing, to the proper temperature for hardening and then quenched and drawn to the required hardness. In general, the heat-treatment of drop-forgings is based on the same principles as those that govern other steel parts, although there are a few special conditions that arise in handling steel in this form. The higher the carbon content, up to 0.90 per cent, the lower the quenching temperature should be. Likewise, nickel has a similar effect to carbon in lowering the upper critical temperature of iron. The method of heat-treating medium sized chrome-nickel steel forgings employed in a plant engaged in the manufacture of airplane motors is as follows: The forgings are gradually and uniformly heated to from 1425 to 1500 degrees F. and held at this temperature until thoroughly soaked. They are then removed from the furnace and quenched in warm water, maintained at a temperature of 115 to 120 degrees, for a period of twenty seconds. The forgings are drawn immediately at 1000 to 1200 degrees F., depending on the exact chemical analysis of the steel. The practice of drawing immediately after the quenching overcomes the tendency of the steel to crack. In some other plants the practice differs from that described in that chrome-nickel forgings are quenched in oil instead of in water.

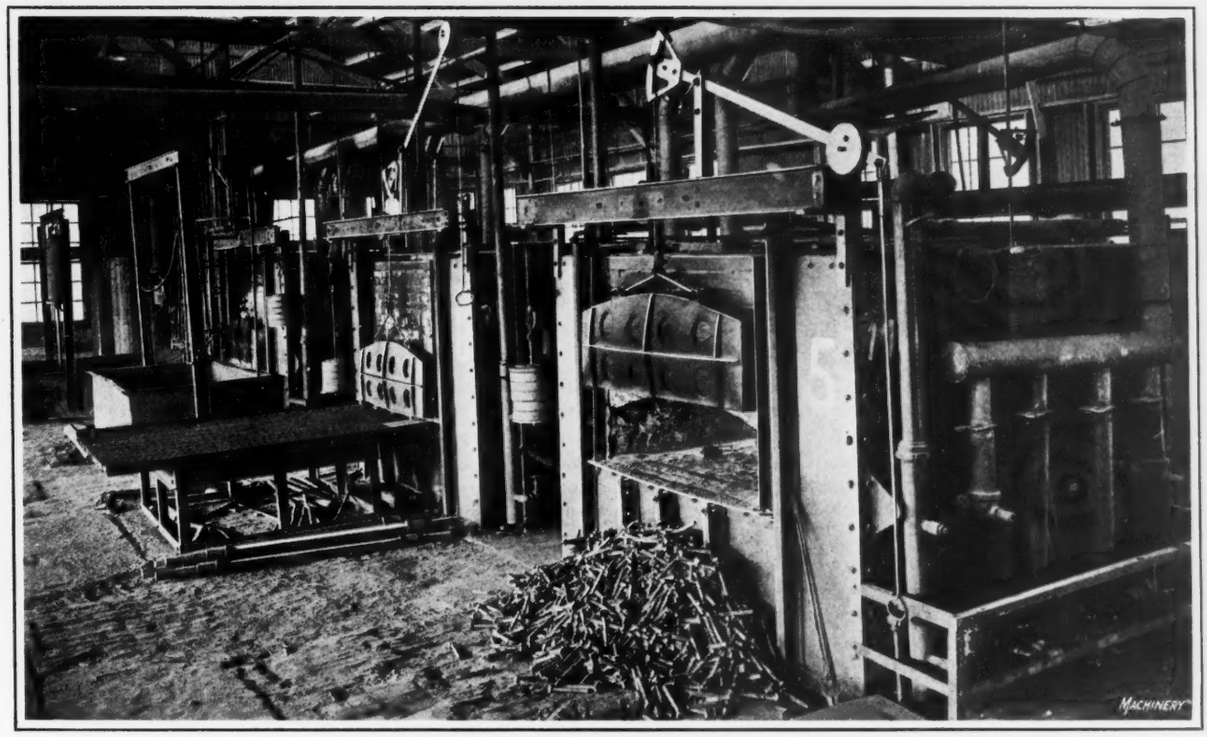


Fig. 2. Battery of Heat-treating Furnaces for Drop-forgings

Types of Furnaces

Of the three designs of fuel-burning furnaces—muffle, semi-muffle and car-bottom—it is probable that the semi-muffle type is the most economical to operate from the standpoint of fuel consumption. The muffle type furnace, although furnishing an even distribution of heat, requires more fuel consumption to penetrate the refractory lining of the furnace and reach the work. The car-bottom type of furnace is advantageous in charging and discharging, but in recharging, the bottom of the car becomes cold and must be reheated with each charge, resulting in the consumption of an increased amount of fuel. The car-bottom type of furnace is excellent for annealing large quantities of parts, for which work uniform results can always be had with this style furnace.

City gas is a satisfactory fuel for the muffle or semi-muffle type of furnace, and with this fuel the flame is short and the distribution of heat good. However, the cost of artificial gas is so high, that it is never used in localities where natural gas is procurable. Oil-burning furnaces are provided with burners and a low-pressure air line for atomizing the oil. By regulating the supply of air, the amount of oxidation which will occur, when burning oil, can be controlled and a soft flame obtained.

Anthracite coal as a fuel is still used in certain types of furnaces, but with varying results. The flame is not a highly oxidizing one, and in this respect the fuel has some advantages. Powdered or pulverized coal which has been passed through a fine 200-mesh screen and blown into the combustion chamber at low pressure may also give good results. The best success with pulverized coal will be obtained in small furnaces.

While oil- and gas-burning furnaces are used extensively in modern heat-treating departments, the application of electricity to the heating of furnaces is the most recent method in use, especially where the temperature must be under more absolute control than can be obtained in fuel-burning furnaces. Furnaces of this type are ordinarily of comparatively small size, so that there are certain limitations to their use for heat-treating large work. The electric furnace is best where results of an exacting nature are required, and in the continuous type of furnace electricity is almost invariably employed. The power cost, however, is high, and in some localities where large power companies do not exist, it is almost prohibitive. Control equipment must be used; this consists usually of a relay system, actuated by pyrometers, which produce electric contact with a switch or operating mechanism by means of which the

supply of electricity is regulated. The pyrometer, of course, registers the heat only in that part of the furnace in which the thermo-couple is located, and is used by the furnace operator principally as an aid in judging the temperature of the other parts of the heating chamber.

Two methods of heating an electric furnace may be used —the electric arc and the resistor. For heat-treating purposes, the electric arc is not suitable, because the heat is not distributed properly, and the gases developed by the arc have a detrimental effect on the work. The resistor type of electric furnace is therefore invariably used, but it is limited by the amount of heat that the metal of the resistor will withstand. Under ordinary circumstances this temperature is about 2000 degrees F., so that for most commercial heat-treating purposes it is suitable, since a temperature as high as this is rarely required. A resistor of chrome-nickel alloy is highly satisfactory, although carbon and graphite resistors are being used considerably with some success. Resistors made of other materials than those mentioned are inferior and will not be found satisfactory.

Furnace Equipment and Design

In some plants where the work is small and is pot-annealed, the furnaces are installed in a pit so that the hearth is on a level with the floor of the heat-treating department. (See the heading illustration.) This facilitates the loading of the furnaces and the removal of the pots, and in such a case the arrangement is preferable to one where the hearth is elevated.

In designing a furnace, the kind of fuel which it is advantageous to burn should be kept in mind, this of course being influenced by local conditions. The heating chamber should be designed so that the radiant energy from the arches will fall on the work being heated, but not so that the flame will come in contact with the work. If large work is being heated and is laid directly on the hearth of the furnace, care should be taken to select a refractory material for the hearth, which will withstand the destructive effect of dragging the work back and forth. A cheap grade of firebrick, machine made, will be found suitable for this purpose, because it is hard and resists friction. The walls may be lined with any of the commercial furnace linings, but they need not be as hard as is required for the hearth.

The continuous type of furnace, in which a conveyor carries the work through, is especially suitable for handling small work. This same principle of automatic heating, when the parts to be treated are comparatively large, is incorporated in the intermittent type of furnace. This arrangement provides for advancing the work to a certain section of the furnace and after it has acquired the proper temperature, advancing it still farther, intermittently, until the work has been properly heated. Continuous and intermittent heat-treating furnaces may be heated by electric current, although a fuel fire is more commonly used.

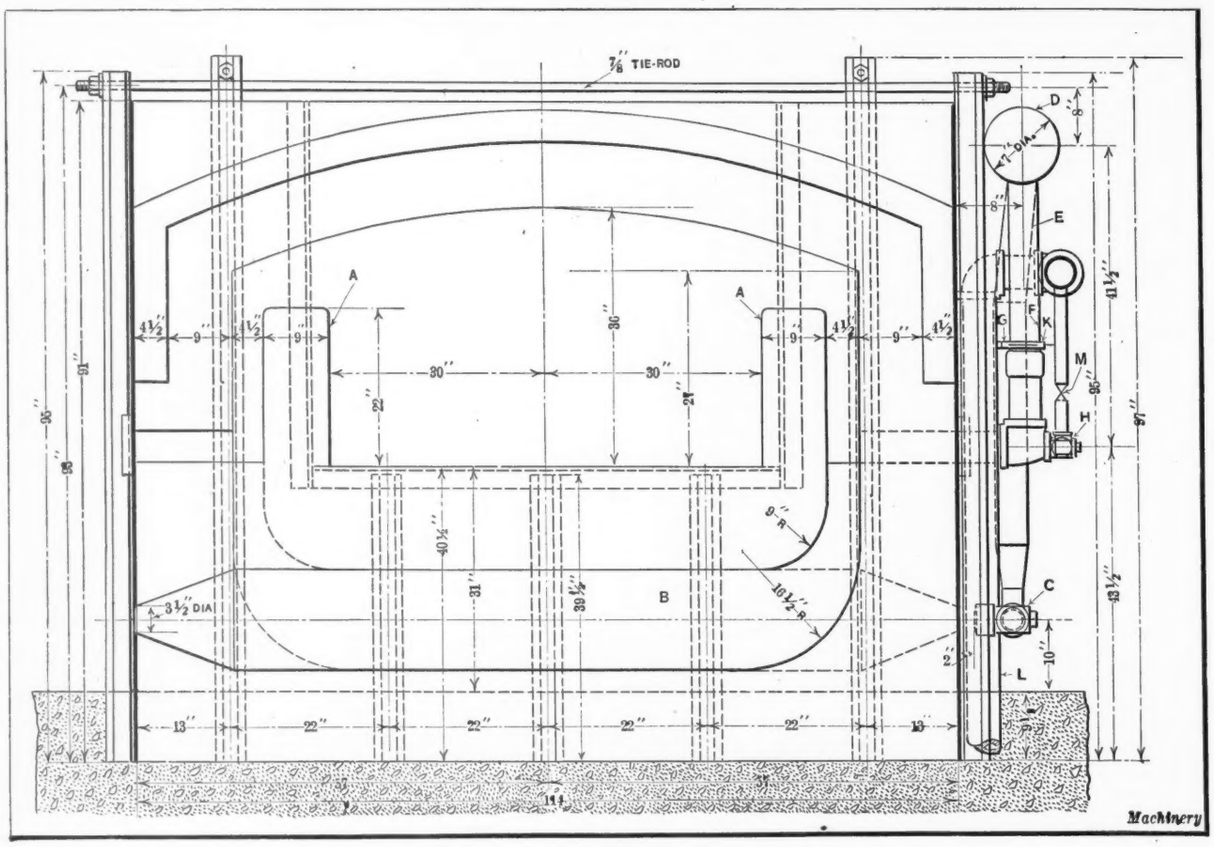


Fig. 3. Design of Combination Oil and Gas Furnaces shown in Fig. 2

A battery of heating furnaces used in the heat-treating department of a large drop-forging concern is shown in Fig. 2. This drop-forging plant has a rated monthly output of 1800 tons, and for handling this work there are eight of these large furnaces, the proportions and design of which are shown in Fig. 3. These furnaces are a combination gas- or oil-burning type of special design. The protective walls *A* are arranged so that the heat will radiate from the arched roof, thus providing a semi-muffle construction which affords ample protection for the work. There are four combustion chambers *B*, equally spaced under the furnace hearth. These are fed by gas burners *C*, two on a side, arranged alternately and connected directly with the supply pipe (not shown in the illustration). The blast line is located at *D* and runs the depth of the furnace. There are suitable valves for regulating the gas flame located along the gas line. The blast for the gas burner is regulated by dampers *G* in pipes *E*, and when gas is not used, is shut off and the air for the oil burners *H* admitted through dampers *K* located in pipes *F*. The oil supply pipes *L* are laid underground. The admission of oil to the burners is regulated by valves located at *M*.

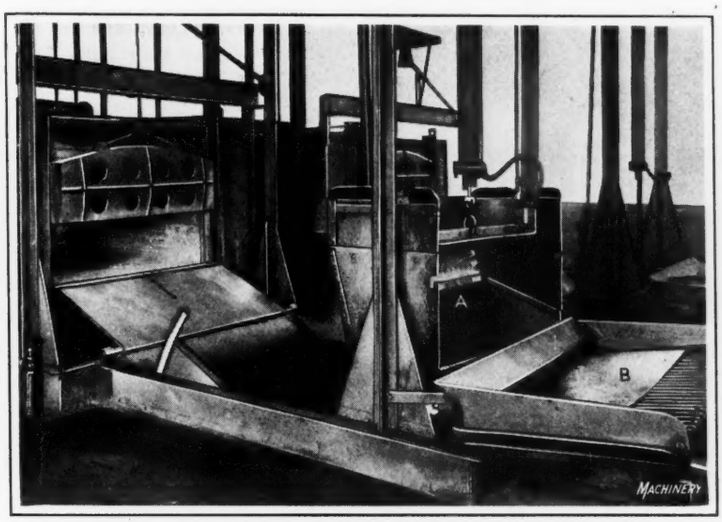


Fig. 4. Front View of Furnace, showing Chute leading to Quenching Tank and Air-operated Shovel

These furnaces are equipped with four pyrometers each, with leads to a central control station. The man in charge of the control station is required to notify the furnace men of the temperature of each furnace and the proper time for drawing the heats. This is done by means of a telautograph, so that as the temperatures are written down by the man in charge of the instrument, this reading will be duplicated at each of the stations which are located in different parts of the heat-treating room, as well as in the laboratory. This enables not only the furnace man but also those in the laboratory who are interested in the progress of any particular lot of forgings being treated, to keep in close touch with the heats. These readings are taken every twenty minutes so that the progress of the heating can be closely watched.

It will be seen that the furnace hearth is above the floor level, which is a desirable condition when comparatively large pieces are being heated. This arrangement makes it possible for the parts to be pushed out at the opposite end of the furnace on the floor where they can either be permitted to cool, or immediately picked up and placed in a convenient place for subsequent treatment. A portable hoist is provided for this purpose. The quenching tanks, which are located in front of the furnace, are equipped with gratings for holding the work. These gratings are operated by an air hoist as may be seen at the left in the extreme background of Fig. 2.

The facility with which work of this kind can be handled will be understood by reference to Fig. 4. Here a front view of a furnace is shown, with the door raised and a chute in position, down which the heated work slides into the oil quenching tank. The scoop or shovel *A* rides in a suitable framework, and is operated by compressed air. The air cylinder is shown in the illustration, as well as the supply hose for admitting the air to the cylinder. The construction of the shovel is such as to permit it to be swung on trunnions and scrape the bottom of the tank, like one-half of a grab bucket. The forgings are deposited from the shovel on the grating *B*, allowing the oil to drain back into the tank. The depth of the tank is about four feet.

In addition to these furnaces and their quenching tanks, this department is also provided with a number of small furnaces for casehardening and cyaniding small work and for various hardening requirements.

General Notes Relating to Heat-treatment

The variation in the compositions of steel makes it practically imperative to follow the fixed rules regarding time requirements in heat-treating the various types of steel. The experiences of the man in charge, in connection with the recommendations of the metallurgist, are usually followed. The work should be heated to about the same color as the refracted light from the furnace walls, which, in connection with the use of pyrometers, will enable the heating and drawing time to be closely approximated.

As a means of assisting in keeping a record of various parts which have been heat-treated so that a precedent for handling similar work may be had, the practice is followed in one shop of making a "prolong" on each forging to be subsequently cut off and used as a test piece. After the heat-treatment has been completed, the "prolong" is cropped off and numbered to correspond with the piece from which it was cropped. All or a portion of this is machined into various types of test pieces, and these are tested to see if the forging meets the tensile and impact requirements. The parts are not permitted to leave the heat-treating department until satisfactory results have been obtained from the tests. It has often been found necessary to reheat the forgings as a result of information obtained from the tests, in order to obtain the desired physical qualities in the forgings. These test pieces are filed away for future reference when similar work is being treated.

Accessories Required in a Heat-treating Department

In addition to the furnaces and quenching tanks, there should be included in the department a medium-sized open frame drop-hammer for use in correcting excessive distortions due to heating, particularly if the work is long like an axle or crankshaft. A hammer of this type will reduce materially the amount of subsequent straightening necessary, and for crankshafts is really essential. There is usually space enough in a corner of the heat-treating department to accommodate the accessory equipment. This equipment will include, besides the hammer, an air compressor which furnishes air for operating the grating hoist cylinder for the quenching baths (if this equipment is used), a blower for the furnace blasts, a straightening machine, and a machine for testing hardness.

Fig. 5 shows a Metalwood straightening machine used for the final straightening of such parts as camshafts and crankshafts. This machine employs an anvil which is operated by air pressure. The crankshaft is supported between centers on the table of the machine, so that it may be turned as required to locate the shaft when applying pressure. Fig. 6 illustrates the use of the Brinell machine for testing the hardness of a motor truck axle. The machine is enclosed in a closet, when not in use, so as to protect it from varying atmospheric conditions, which are so noticeable in a heat-treating department. By this means, a higher degree of dependability can be placed on the results obtained in making the test.

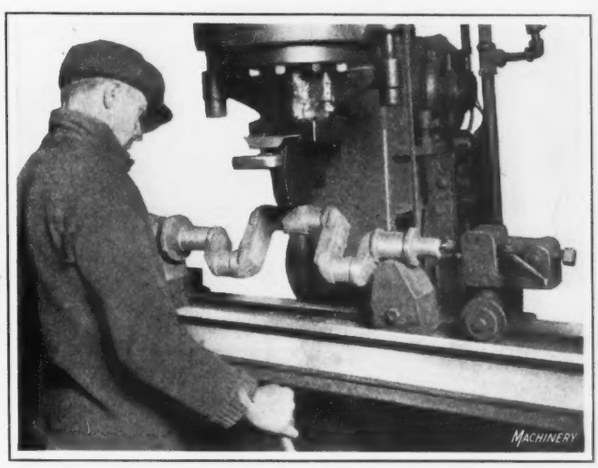


Fig. 5. Straightening a Crankshaft Forging

After the drop-forgings have been heat-treated, they are transported to the cleaning department in which the tumbling barrels, pickling solution tanks, and sand-blasting equipment are installed. If the forgings are to be machined subsequently, they should be pickled in a dilute solution of sulphuric acid, or other suitable bath. Small parts may be cleaned by tumbling, which is an effective method of removing the scale and fins from the surface of the forgings. Large parts cannot, of course, be tumbled, and if a sand-blasting equipment is not available, the parts may be gone over with a wire brush to remove the scale. However, sand-blasting is the most effective method of handling all sizes of work.

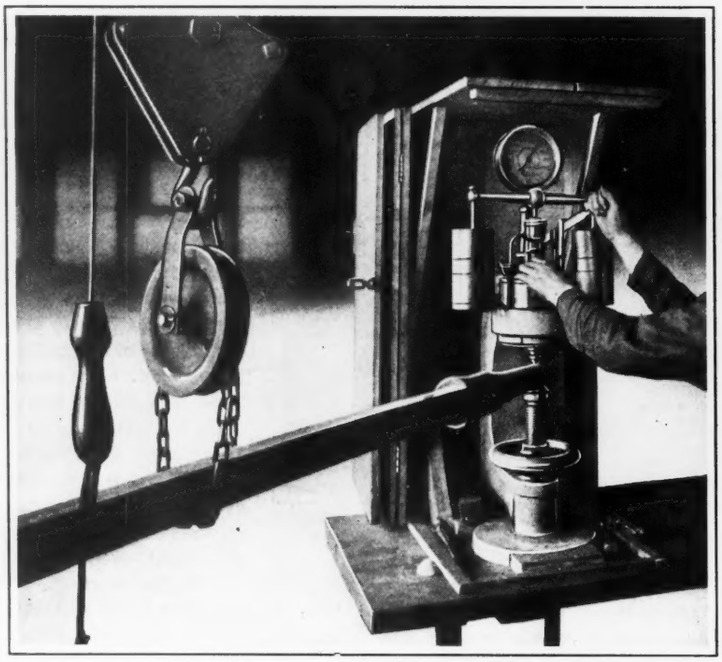


Fig. 6. Motor Truck Axle being tested by Brinell Hardness Testing Machine

MACHINERY is indebted to the Union Switch & Signal Co., Swissvale, Pa., and to J. H. Williams & Co., Brooklyn, N. Y., for their cooperation in preparing the series of articles of which this is the last.

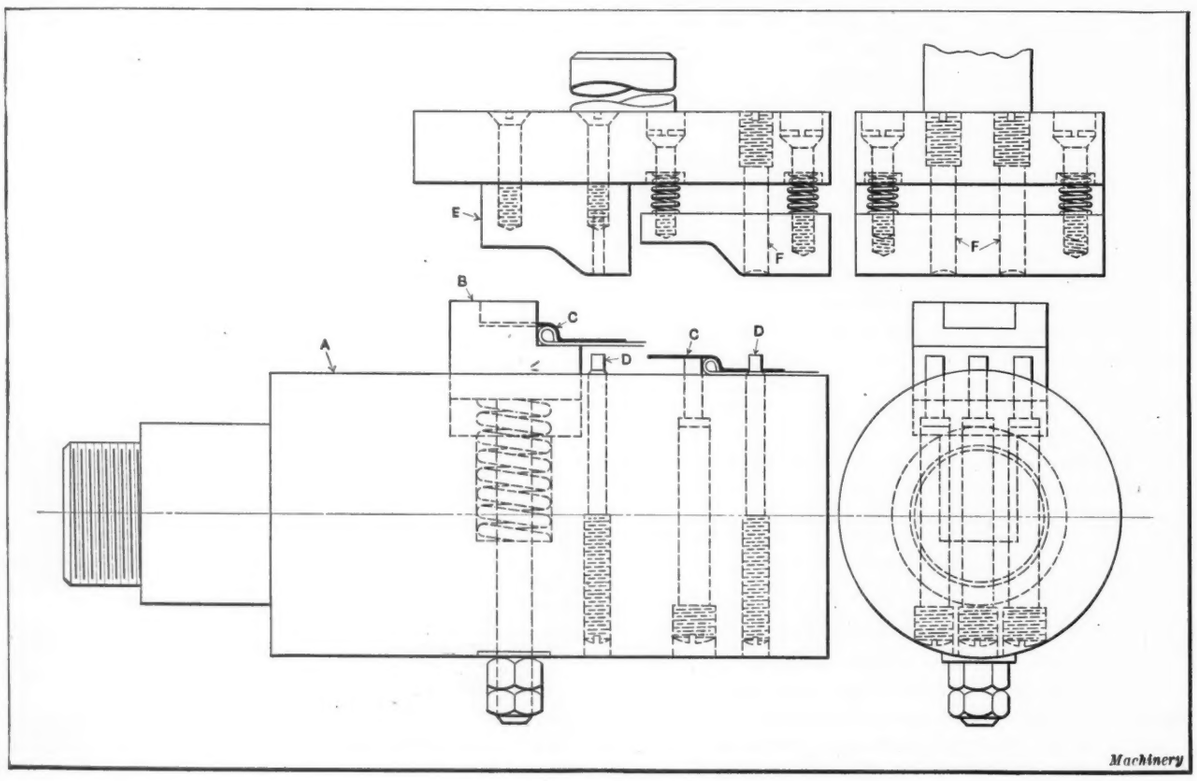
* * *

RIVETING DIE

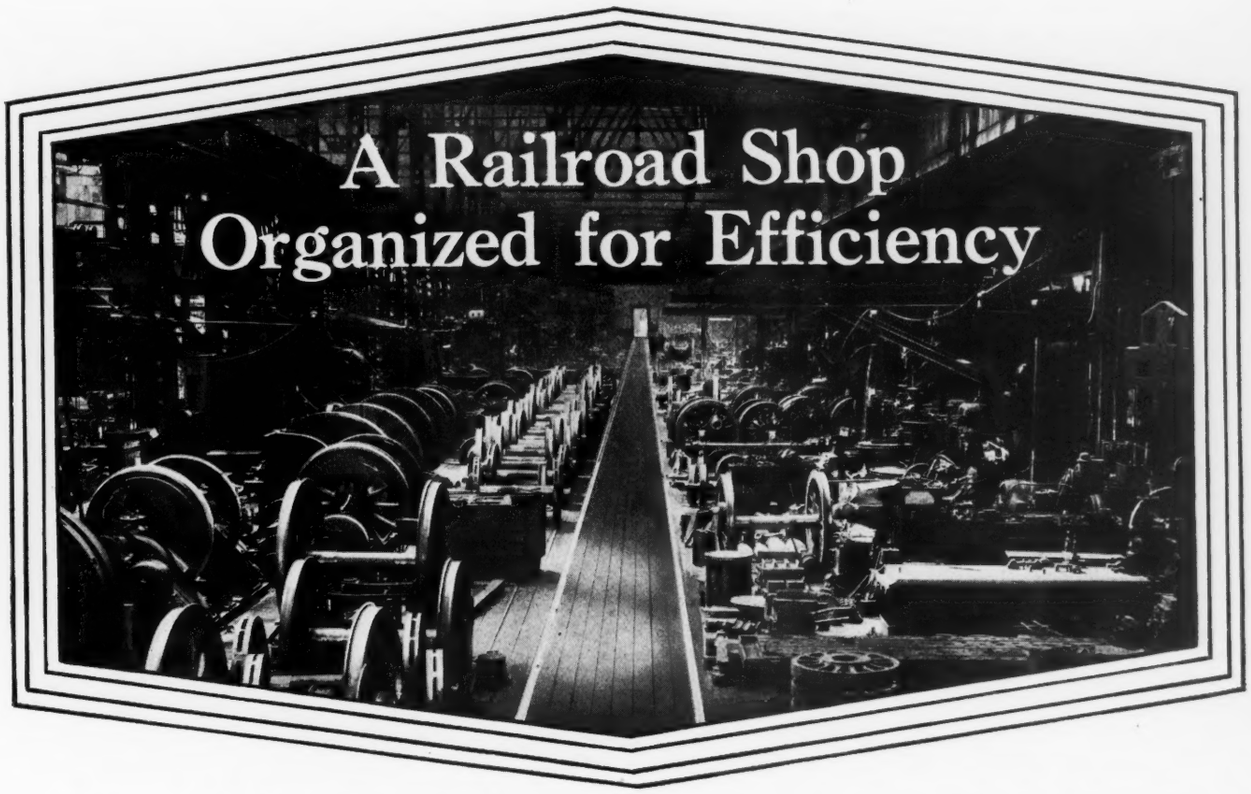
By D. C. OVIATT

The riveting die illustrated is used for attaching ears to tin pails. The cylindrical horn *A* is attached to the power press, extending out horizontally so that the pail may rest on it while the ears are being riveted in place. The pail is abutted against the spring gage block *B* as shown in the illustration, and the ear *C* laid on it in the proper position for riveting. The rivets *D* are set in suitable depressions in the horn, these depressions being formed by special long screws which do not extend quite to the circumference on the horn. To permit the depth of depressions to be maintained regardless of wear produced in the riveting operation, it is merely necessary to adjust the screws to the proper depth. The upper member carries a punch-block *E* which, on the descent of the press ram, forces the gage-block and the work which it supports down until the rivets have pierced the pail and ear. The second position of the pail, with the ear partly assembled, is shown near the end of the horn. The ear is supported by spring pins during the riveting operation which takes place with the work located in the second position. The riveting punches *F* are protected by a spring-backed guard block which, when the press ram descends and the rivet is set down, rests on the ear and acts as a shock absorber.

Work of this kind is usually done on a regular horning press that is arranged especially for the performance of rivet-setting operations of this nature, but such a press is not required when dies constructed according to the general design illustrated are employed.



Die used on Power Press for riveting Ears to Pails



Equipment and Methods Employed in the Angus Shops of the Canadian Pacific Railway Co. Montreal, Canada—Second of Two Articles

By EDWARD K. HAMMOND

IN the first installment of this article, which appeared in the December number of MACHINERY, the general arrangement of the Canadian Pacific Railway shops at Montreal, Canada, known as the Angus shops, was described, and a plan of the shops was shown. It is the purpose in the present installment to show designs of jigs and fixtures used, and to outline some of the methods that have made it possible to reduce costs in the Angus shops.

Design of Multiple Jigs and Fixtures

With a view to bringing production conditions in a railroad shop as nearly as possible into line with those that obtain in the best manufacturing organizations, the jigs and fixtures in the Angus shops have been designed, wherever possible, to provide for a multiple set-up of engine and car parts. As a case in point, consider the equipment shown in Fig. 1, which is used for planing all flat external surfaces of locomotive cylinders. By using a fixture of this kind two castings can be set up at a time, and a number of pairs of cylinders, depending on the capacity of the planer, can be handled in a single operation, thus substantially increasing the rate of production.

The method of procedure is quite simple. The cones *A* are provided with steps to enter the finished bore of cyl-

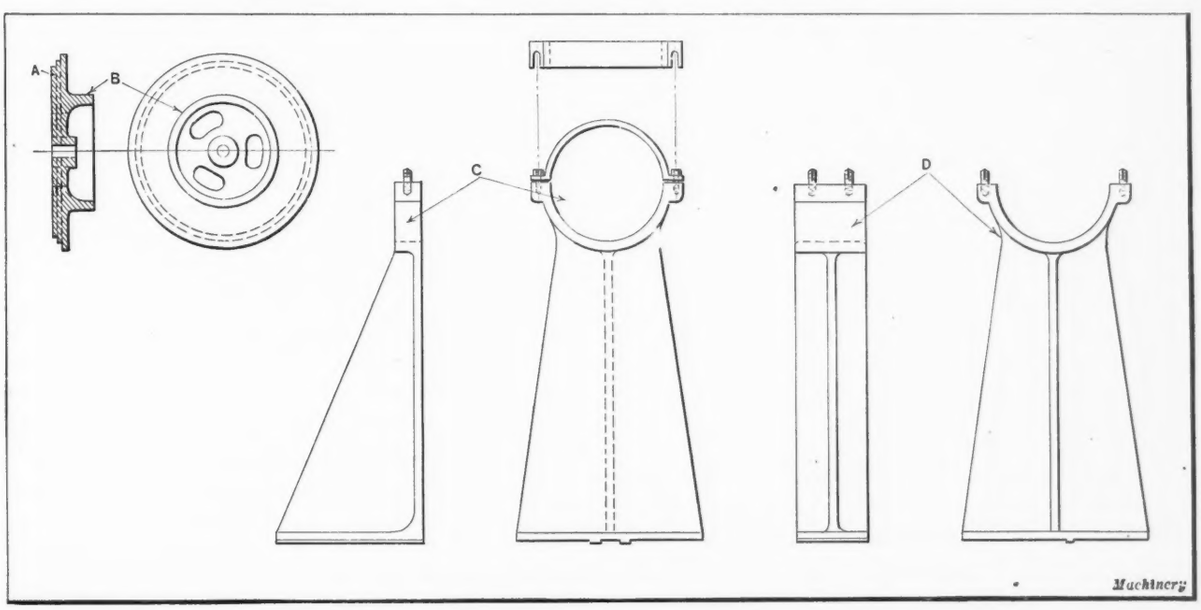


Fig. 1. Fixture used in planing Locomotive Cylinders, which is designed to hold Two Castings at a Time

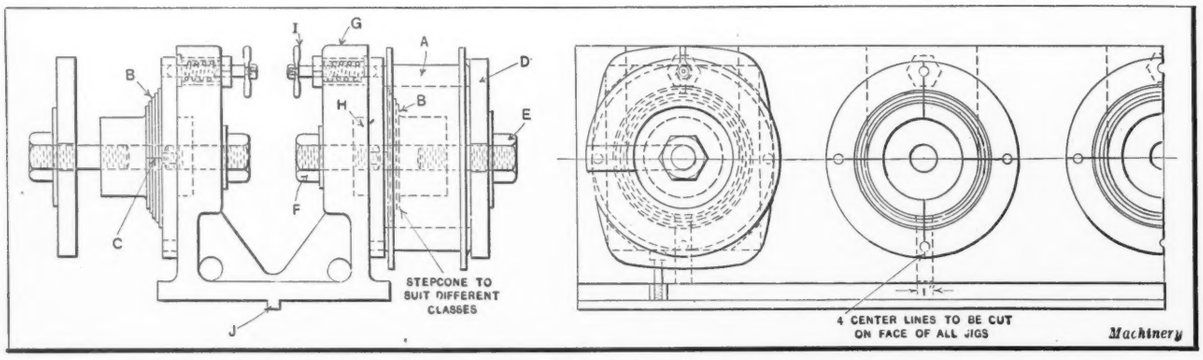


Fig. 2. A Multiple Planing Fixture for Use in machining Main- and Side-rod Brasses

inders of various sizes, and these cones have hubs *B* which enter sockets *C* in the supporting members. Each fixture consists of three parts, namely, two end pieces *C* and a center support *D* that is also arranged to hold a pair of cones *A* projecting one at each side. Obviously, three supporting members arranged in this way have cones *A* in each end of a pair of cylinders. The work is located and leveled up for finishing the joint, frame fits, and other surfaces that have to be planed, according to standard practice. The advantages of such an arrangement are the speed with which the job can be set up and the reduction of planing time that can be effected by the simultaneous handling of a number of castings.

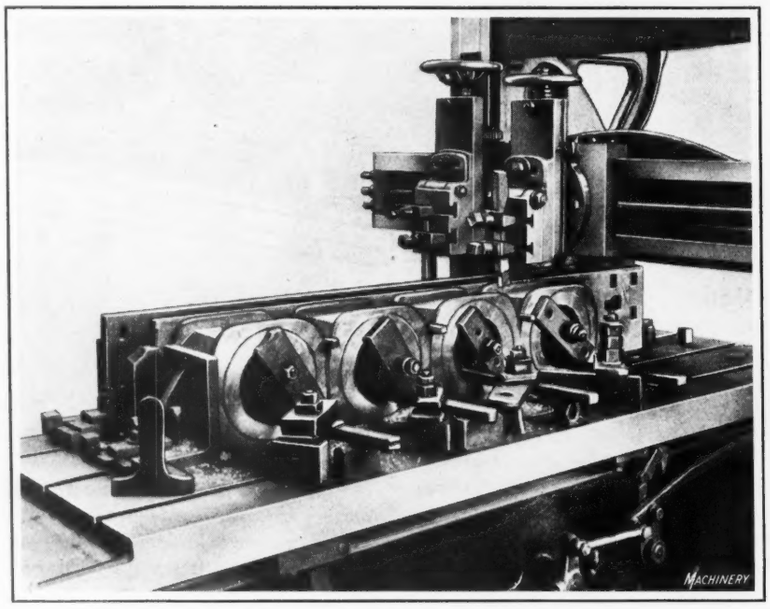


Fig. 3. Gang Planing applied to Rod Brasses

Fixture for Planing Main- and Side-rod Brasses

A better example of economical fixture design is illustrated in Fig. 2, which shows an equipment for use in machining the sides and flanges of bearing brasses for locomotive main-rods and side-rods. In this illustration, one of the pieces of work is shown in position in the fixture at *A*, where it will be seen that stepped cones *B* are furnished for the purpose of handling different sized pieces of work which are previously bored so that the finished hole may be utilized as the locating point.

This fixture is arranged to carry the castings in two rows, and ten pieces of work may be set up at a time. The method of operating the fixture is as follows: After casting *A* has been placed over cone *B*, the line of the joint on which the two halves of the bearing brass are sweated together is brought into coincidence with a graduation line *C*, so that the faces of the bearing brass may be properly finished relative to this joint. Then strap *D* is tightened by means of a cap-screw *E*. When ten cast-

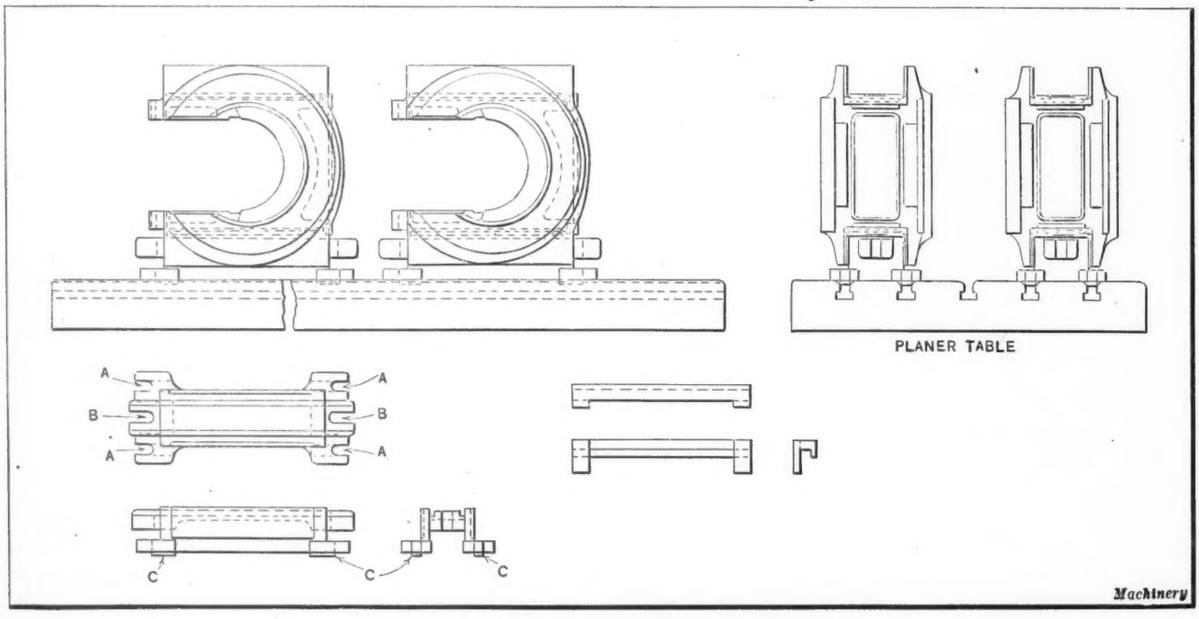


Fig. 4. Multiple Fixture for planing Locomotive Driving-boxes

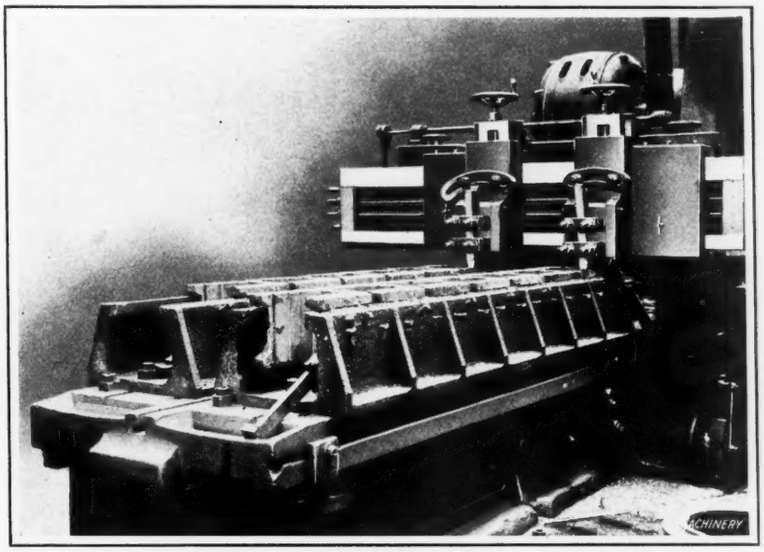


Fig. 5. Planing Two Parallel Rows of Engine Truck Boxes

ings have been set up in this way, the planing operation can be performed on the top face of each piece, two planer heads on the cross-rail being utilized so that the rate of output may be speeded up as much as possible.

After one side of each brass has been finished in this manner, a cap-screw *F* is loosened at the back of each fixture, so that cone *B* and the work carried by it are slightly released from the finished face of bracket *G*, against which each work-holding fixture is tightened. At the back, cone *B* is provided with a boss *H* that enters a socket in bracket *G*. After cap-screw *F* has been loosened, index-pin *I* is withdrawn from the hole in the back of cone *B* and the work is turned through a quarter revolution, after which the index-pin is allowed to snap back into position in the next hole. Then cap-screw *F* is again tightened. After each of the ten pieces of work has been reset, the planer-hand is ready to machine the next face on the castings. Four such sequences of operations are required to complete the job. This fixture is located on the table by a tongue *J* which enters one of the T-slots. Fig. 3 shows a row of rod brasses on the planer.

Fixture for Planing Driving-boxes

For planing the shoe and wedge faces of driving-boxes, the arrangement of the work on the planer table is similar to that employed in the case of the bearing brasses handled on the fixture shown in Fig. 2. However, the design of the fixture used for handling this work is quite different. In the present case, each piece of work is held in a separate fixture, the form of which is best shown at the lower left-hand corner of Fig. 4. Here it will be seen that the fixture consists of a member similar in form to a piece of channel iron, with three slots at each end.

The fixture is clamped to the planer table by bolts passing through the four slots *A*, and the driving-box casting is clamped down on the fixture by means of bolts passing through the two slots *B*. The number of castings set up at a time varies according to the type of locomotive on which they are to be used. Three pairs of boxes are set up in two rows, when the boxes are of the type used on eight-wheel locomotives, while in the case of six-wheel locomotives the boxes are planed with two pairs set up parallel to each other. After the shoe face has been planed, this finished surface is used as a locating point in setting up the work to plane the wedge face. The fixtures are provided with tongues *C* that enter T-slots in the planer table. The chief advantage of fixtures of this kind is that they are quite inexpensive to make and still enable a substantial saving of time to be effected through the application of the multiple principle of setting up the work.

The method of planing engine truck boxes is shown in Fig. 5. Two rows are planed at the same time, and the type of fixture used is clearly shown in the illustration.

Device for Casting Bearing Brasses on Shoe and Wedge Faces of Driving-boxes

Driving-boxes for locomotives used on the Canadian Pacific Railway are equipped with brass bearings on the shoe and wedge faces. After the boxes have been planed, the brass bearings have to be put in place, and reference to Fig. 6 will show that dovetailed anchorages *A* are planed in the driving-box to hold the brass securely. A better idea of the arrangement of the fixture *B* will be obtained by reference to Fig. 7, which shows the device in detail. It consists of three lateral members *C*, *D*, and *E*, which are assembled to form the composite plate, and two cross-strips *F* and *G* which carry bolts that hold the lateral members together.

Plates *C* and *E* are tapered in one direction and *D* is tapered to an equal degree in the opposite direction, so that when the three are assembled they form a single plate with parallel edges. Strips *F* and *G* are slotted in such a way that bolts passing through them have the necessary play to allow the center plate *D* to be adjusted by tapping a head *H* which is welded on it for that purpose. By slightly loosening the bolts and then tapping this head, plates *C* and *E* may be extended or drawn together so that they just fit the space in the driving-box. Conical-headed screws *I* rest against the planed shoe or wedge face of the driving-box, thus holding the plate at a sufficient distance from the box so that a brass bearing of the required thickness may be cast. The entire device is held in place by putting a heavy piece of iron against it while in position in the driving-box;

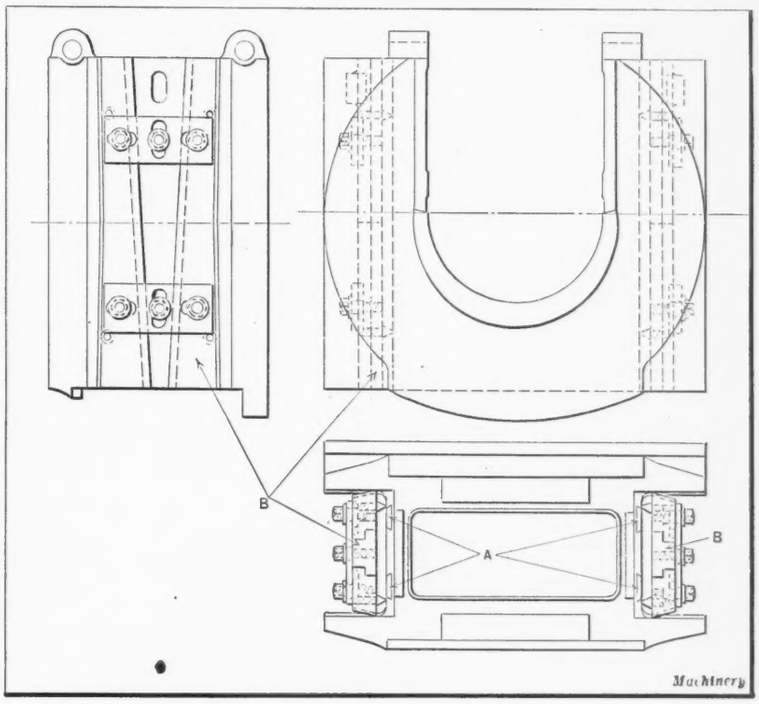


Fig. 6. Driving-box and Fixture used when casting Brass Bearings on the Shoe and Wedge Faces

and the space at the bottom, as well as the joints between the edges of the plate and the flanges on the driving-box, is luted with fireclay to prevent the brass from running out.

Drill Jig for Replacing Dry-pipe Sleeves

Removing a sleeve from the end of a dry pipe in order to substitute a new one is not so simple an operation as fitting a new sleeve, because the new holes in the sleeve have to be drilled in alignment with the old ones previously made in the end of the pipe. To provide a convenient means for performing this operation, a jig shown in Fig. 8 has been developed, which is strapped into place on the table of any sensitive drilling machine. The jig consists of two arms, one of which carries a spring-pin *A* that enters successively the holes in the old dry pipe, while the other arm carries a drill bushing *B* that is located directly over the spring-pin. When the drill is fed down through this bushing, it produces a hole in the sleeve, the position of which coincides with that of the hole in the old dry pipe. After one hole has been located and drilled in this manner, the pipe is turned until pin *A* enters the next hole, after which the corresponding hole can be drilled in the new sleeve. By this method very little time is required to drill a series of holes, the location of which might otherwise cause considerable trouble.

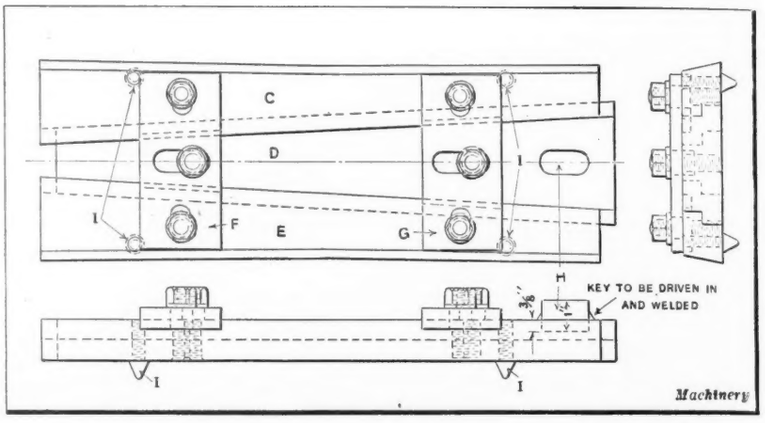


Fig. 7. Fixture used for casting Brass on Shoe and Wedge Faces of Driving-boxes

Method of Handling the Labor Problem

Two measures have been adopted in the Angus shops which have been quite effectual in overcoming difficulties with labor. One of these is the application of a system of employe representation. The other is the use of what is known as a "contract" system to encourage industry on the part of the workers and to afford an opportunity for exceptionally industrious or capable men to earn more than the normal hourly rate of pay. This contract plan works out as follows: A so-called "contract price" is fixed for each job, and each class of workers in the plant is paid a specified scale of wages, which is guaranteed. All men working on contracts are credited daily with the cash value of the work done, and they are charged with the amount represented by their wages while on that job. All shop men are paid every two weeks, and once a month they receive as a bonus any difference between the amount earned on their contracts and the amount of the wages which have been charged against the job. According to this system, it is possible for good men to earn 20 or 25 per cent over their regular rate of pay.

Duties of the Contract Foremen

In carrying on this work, there is one contract foreman to approximately every seventy-five contract workers—in many cases less, never more. They are selected from the best mechanics in the shop and placed on the monthly payroll. Their duties are twofold: First, to recommend to the general supervisor of piecework, contract prices for the different jobs; and, second, to inspect the finished work and to credit the men with the number of pieces that pass inspection. It is important to note that these contract foremen are entirely independent of the shop supervision. In conducting their work, if they see ways in which they believe that the efficiency of an operation could be improved, it is their duty to go to the foreman of the department and make a recommendation for the change. If the change is not made within a reasonable time, the contract foreman takes the matter up with the head of his department. In this way, a constant check is kept on the plant's productive efficiency and weak points do not long remain undetected.

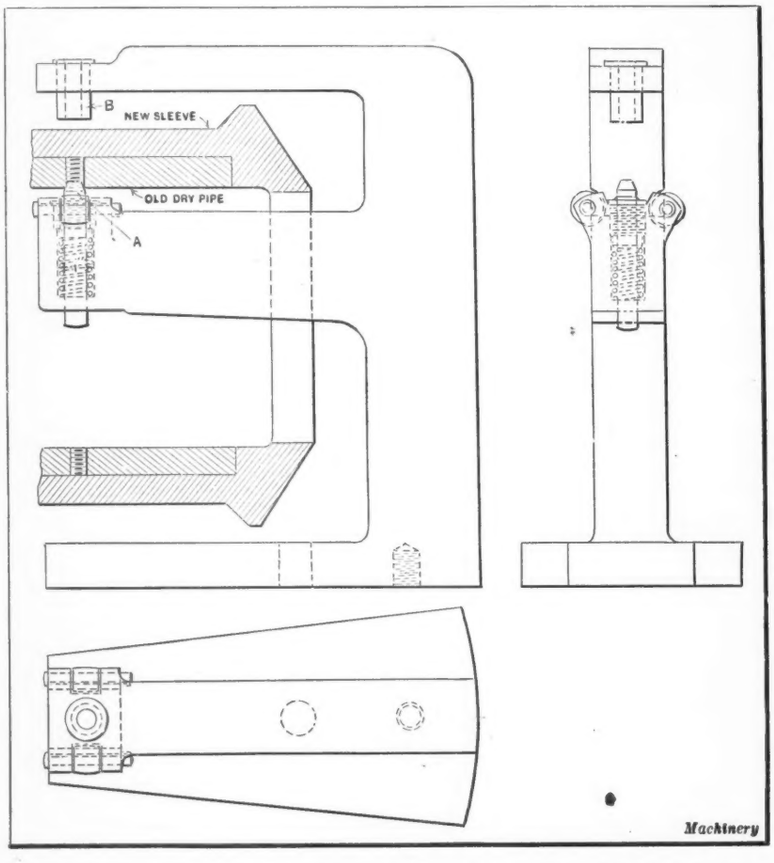


Fig. 8. Jig for drilling Holes in New Dry-pipe Sleeve in Alignment with Holes in Dry Pipe

* * *

As an indication of the difficulty of selling American machine tools abroad, the following figures will prove of interest. A shaper of American make selling at $720, dealer's price, F.O.B. New York, is copied by an Italian manufacturer who delivers the machine in Paris, duty and transportation charges paid, for $465. The freight and delivery charges on the American machine would add about $75 to its cost in France, and in addition the import tariff would have to be paid. Even though it is understood that the copy of the American machine is not equal, in quality, to the original, it is clear that when the copy is sold for about one-half the price of the American machine in Paris, the advantage is with the copy.

Grinding Multiple Spline Gages

By C. F. SCHLEGEL

THE following method of grinding multiple spline gages having six or more splines has been used successfully by the writer. The fact that fifteen or twenty multiple spline gages with limits of 0.0002 inch in both size and spacing of the splines were ground by this method without the loss of a single gage gives evidence of the accuracy of the method. A description of the procedure in grinding a gage with six splines, such as shown in Fig. 1, will make the method clear. First grind the outside of the gage on a cylindrical grinder, leaving the work a little over size for finish-grinding, and of a dimension which permits the circumference to be easily subdivided without using complicated fractions. Next mount the gage on centers and on a surface grinder, indicating both the top and the side of the gage to insure accurate alignment, and taking care not to subject the work to any strain when securing it to the center head.

Now grind the gage surfaces S between the splines by employing the center head to rotate the work while moving the table forward and backward. To finish these surfaces, it is necessary to go over the gage two or three times to insure concentricity of the surfaces with the axial center line. An angle-plate A is mounted firmly on the table of the grinding machine, care being taken to see that it rests close against the outside surface of a spline which is located in a horizontal plane passing through the axis of the gage. The face of the angle-plate must be set true or parallel with the axis of the work, and also at 90 degrees from the surface of the table.

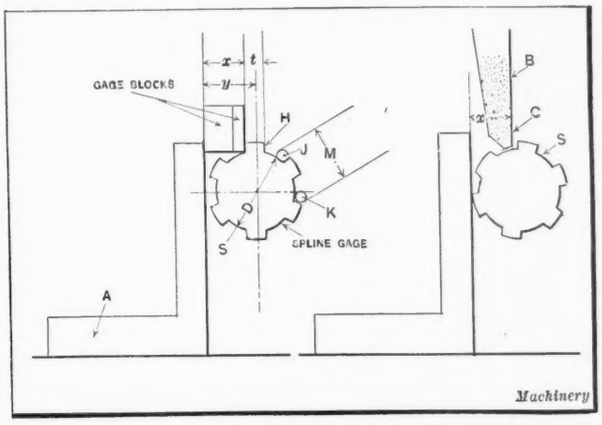


Fig. 1. Method of locating Work and setting Wheel for grinding Spline Gages

A saucer wheel B, dressed off on the periphery and side as shown in the illustration, is set 0.002 inch above the body surface S of the gage, the grinding face C of the wheel being set at a distance x from the face of the angle-plate. The grinding machine table is next moved back sufficiently to permit the gage to be revolved by means of the center head until a spline is brought approximately central at the top, making the distance x, shown in the view at the left, Fig. 1, 0.004 or 0.005 inch less than $y - \frac{1}{2}\ t$. Without raising or lowering the wheel, grind the side of the spline until dimension x equals $y - \frac{1}{2}\ t$. The cross-feed of the table is used in performing this grinding operation, and size blocks are employed for gaging dimension x.

The machine table is then moved forward and the gage revolved a sufficient amount to allow the grinding wheel to enter the next space. The side of the second spline is then ground, using the center head to feed the work to the wheel. The accurately ground wires J and K are placed in contact with the ground sides of the two splines as indicated. The side of the second spline should be ground until a micrometer measurement over wires J and K shows that this distance is only 0.0001 inch less than the calculated dimension M. Dimension M is calculated as follows: Add to diameter D the wire diameter; multiply by the sine of 180 degrees divided by the number of splines; add the product to the wire diameter. Expressed as a formula,

$$M = (D + d)\left(\sin\frac{180\text{ deg.}}{N}\right) + d$$

in which d equals diameter of wire and N the number of splines. Care must be taken to keep the wheel in a free-cutting condition, and the distance from the faceplate to the face of the wheel, as indicated by dimension x, should always be maintained, the wear on the wheel being compensated for by means of the table cross-feed.

The spline gage is next revolved until the two ground splines are in the position indicated in the view at the left, Fig. 1, with the rods J and K in contact with the ground sides. Two adjustable dial indicators F and G, Fig. 2, are then mounted on a toolmaker's surface gage as shown, and adjusted until both indicators show a reading of approximately zero when the ball points pass over their respective rods J and K. The ball point of the upper indicator should pass over the rod J a little in advance so as to enable the workmen to easily read both indicators correctly. All clamping screws should next be tightened, and the indicators adjusted to read exactly zero when their contact points pass over the rods.

The spline gage should then be revolved so as to bring the next or third spline into the grinding position. This spline should be ground until both indicators F and G register zero. The work must, of course, be tested frequently during this operation by placing wire J in contact with the surface being ground, and revolving the work until it reaches the gaging position indicated in Fig. 2. This method of grinding and testing is employed in grinding one side of each of the six splines. The distance between the ground faces of the first and sixth spline will undoubtedly be a little greater than that between the faces of the other splines, say 0.0018 inch greater. Therefore, the distance between the ground faces of the other splines should be increased by 0.0003 inch. With the spline gage set so that the lower indicator shows a reading of zero when the gaging point passes over the ground face of the second spline, proceed to adjust the indicator so that it will show a dial reading of minus 0.0003, or in other words so that 0.0003 inch must be removed from the second spline in order to have both indicators again register zero. The sides of all six splines should then be reground in the manner previously described until all the spaces are exactly equal. It may be necessary to repeat these grinding operations three or four times before the required accuracy of spacing is obtained. Should the space between the ground sides of the sixth and first spline be a little less instead of greater than that required, it is only necessary to find the average discrepancy for each space, adjust the lower indicator so as to lengthen the distance between the two indicator points the amount required to rectify this error, and regrind the gage as previously described.

By taking a very light cut on the side of the first spline, any slight error can be rectified, thus minimizing the danger of spoiling a gage. In finishing the other sides of the splines, size blocks are used that have a total thickness equal to $y - \frac{1}{2} t$ to adjust the work. These blocks are placed between the face of the angle-plate and the ground side of the spline as indicated in the view at the left, Fig. 1. The grinding wheel is then brought into contact with the side H, and the spline ground to the required thickness. During this operation care must be taken to have the corner of the wheel from 0.001 to 0.002 inch above the surface of the body of the gage. The table cross-feed is, of course, employed for feeding the work to the wheel during this operation.

By moving the table in or out a little so that the spline, if pressed against the wheel, will be at an angle of about 1 degree, it is possible to finish-grind the gage so that it will have sharp corners where the sides of the spline and the body surfaces of the gage meet. In performing the latter operation, the gage can be revolved to bring the spline away from the wheel, and the wheel lowered until its edge just makes contact with the surface of the body of the gage. Then, while the work is being moved forward and backward, it can be carefully fed up to the wheel by revolving the index-head, this operation being completed when the edge of the wheel meets the base of the spline. The final operation is that of finish-grinding the outside in a cylindrical grinder.

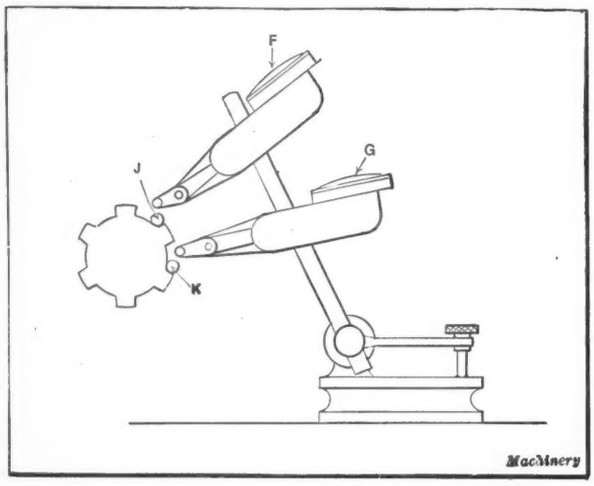


Fig. 2. Indicators used in testing Spacing of Splines

The method described can also be used for grinding index-plates having six or more index points or notches. For this work, the angle-plate is located as shown in Fig. 3. Instead of using size blocks, as in the case of the spline gage, it is possible to use micrometers for measuring dimension x in order to obtain the correct relationship between the sides of the notch and the center line of the work. The back face of the angle-plate must, of course, be parallel with the front face when used in this way. By using two indicators, as previously explained, it is possible to obtain very accurate spacing of the working faces L of the index slots. The other sides or faces M, whether straight or at an angle of 15 degrees—the latter design being preferable—may be correctly spaced by using the index-pin as a gage.

* * *

SWEDISH MACHINE INDUSTRIES

Statistics covering the Swedish machine industries for 1917, the last complete statistics published, show that in that year machine tools were manufactured in that country to a value of $12,000,000; oil engines, $10,000,000; agricultural machinery, not including dairy machinery, $8,000,000; woodworking machinery, $3,000,000; paper-making machinery, $3,000,000; steam turbines, $1,500,000; water turbines, $1,250,000; and bicycles, $5,000,000.

DEVELOPING MACHINISTS FOR JOBS HIGHER UP

By ARTHUR McCOMB

Notwithstanding the fact that the subject of developing men for better positions has been discussed frequently from various angles, there is still something further to be said. It is always good policy for a shop department to have at least one good man in the course of development and ready to take the place of the foreman in case of necessity. The average superintendent or works manager generally selects a man from the shop for the position of foreman, and is influenced in his selection by the fact that the man is most familiar with the work, regardless of his knowledge of handling men.

The writer is a firm believer in choosing men from the ranks when it is possible to do so; but he also believes that such men should be given a thorough training for at least a year before taking the job, so that in addition to the regular shop routine, they may become proficient in the handling of men and in maintaining a maximum amount of production with a minimum amount of attention to detail. The writer has worked for several men who have been taken from the ranks but have not received such training. Failing in this important detail and having no one to assist them at the time they needed assistance most, these men became discouraged, and were not successful in filling the positions.

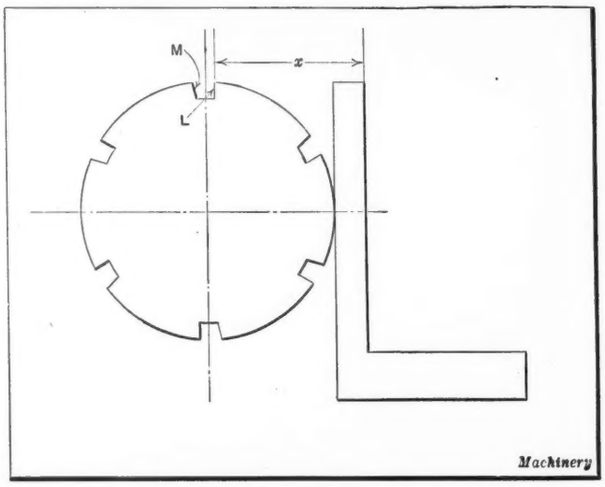


Fig. 3. Locating Index-plate for Notch Grinding

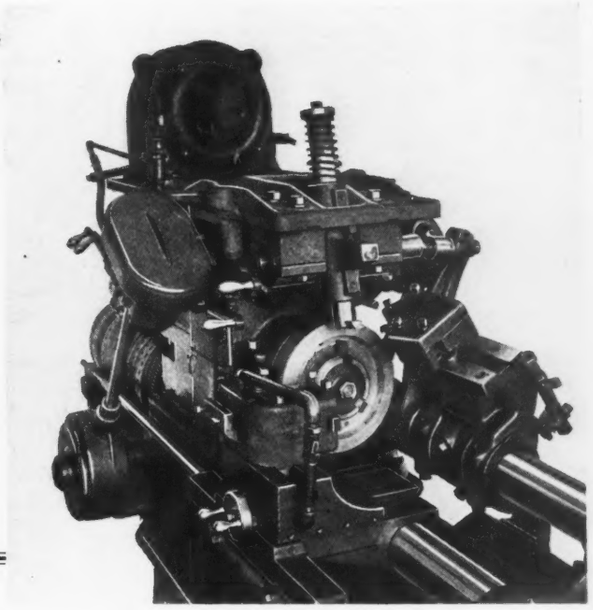
Some superintendents do not recognize the fact that there are men in the machine shop of high enough caliber to make high-class foremen. The writer believes that there are, and that there is hardly a shop of any considerable size that does not employ at least one such man who, if given a little encouragement and responsibility, would develop quickly. Responsibility in the development of a foreman is an important factor. Probably much labor trouble could be eliminated by employing a well-trained foreman who understands both the employer's and the workman's point of view, and who is capable of talking and explaining matters to the men in the right way.

The remark is often made that a certain shop cannot compete with some other concern because it does not have the same high-class workmen. The writer does not believe such a remark justified, because he has worked in a number of different machine shops and finds that as far as the men are concerned they are all very much alike. The one thing that makes a big difference is the foreman's organization within his department, and he can develop this organization until he really obtains high-class work with little effort from men who under other circumstances might not be classed as especially capable. This development work of the foreman also helps him to qualify for a higher position.

Cost-reducing Tooling Equipments

Machines and Tooling Equipments Used for Performing Turning, Boring, Facing and Recessing Operations on Automobile Gears

By RALPH E. FLANDERS
Manager, Jones & Lamson Machine Co., Springfield, Vt.



MACHINE or tool designers who endeavor to develop equipments that will enable one operator to run a large number of machines are extending their efforts in the wrong direction when the work must be inserted and removed by the operator. Their aim should be rather to bring out machines which will be so intensive in production that as few as possible will keep an operator busy, the ideal arrangement being one machine to one operator. In the examples of automobile gear manufacture presented in this article, there is one operator to each two machines.

How To Reduce Production Costs ?

The tooling equipments employed on Fay automatic lathes for turning and facing a stem bevel pinion used in the rear axle drive of an automobile are illustrated in Figs. 1, 2, and 3. This pinion has a projection on the head end which permits it to be driven, in the set-up shown in Figs. 1 and 2, by a hardened and balanced driving plate. The part should have the small end milled, and preferably straddle-milled, so that the end of the projection may be centered to a standard depth, as gaged from the shoulders of the forging. The shank is rough-turned by the tools mounted in the front holder of the equipment shown in Fig. 1, and is necked at the pinion end, and necked and beveled at the small end, by the tools in the rear holder. The formed tool *A*, which necks and bevels the small end, does not come into action until after the turning tool *B* has removed the scale from this end.

The equipment shown in Fig. 2 is employed for the next operation in which the taper surface near the small end is finish-turned by a tool in the rear holder, while tools in the front holder finish-turn the straight portions. The arrows in the various tooling diagrams, show the direction in which the front and rear tool-holders are fed.

On such cuts as those taken by the tools shown in Fig. 1, the work, if properly supported, will stand feeds, speeds, and a number of simultaneous cuts which will consume as much as fifteen horsepower or more, and to be successful in automotive practice the machines should be designed to transmit this horsepower continuously. Since so much depends on the support of the work in determining the output, the question may be raised as to the value of the commonly used driving projection shown, which is of small diameter and lengthens the blank. An alternative scheme that is particularly applicable to parts drilled in the head end is the gripping of this end in a chuck. The chuck drive is the better of the two if it will permit a sufficiently faster cut to compensate for the extra time required in chucking the work.

The gear end of the part is rough- and finish-turned and faced in the next operation, which is performed in a Fay automatic lathe provided with the equipment shown in Fig. 3. The work is gaged lengthwise against the back shoulder of the pinion by abutting this surface against a hardened collar carried on the faceplate fixture. The small end of the part is supported on a spring center, the fixture being slotted to allow the work and driving dog to drop into place. Tool *C* on the front carriage rough-turns the face of the gear, and tool *D* finish-turns it in the same continuous feeding movement. The rear tools do not come into action until the roughing cut has been completed, so that their finishing corners do not become injured by rough scale. In all finishing operations performed in the Fay

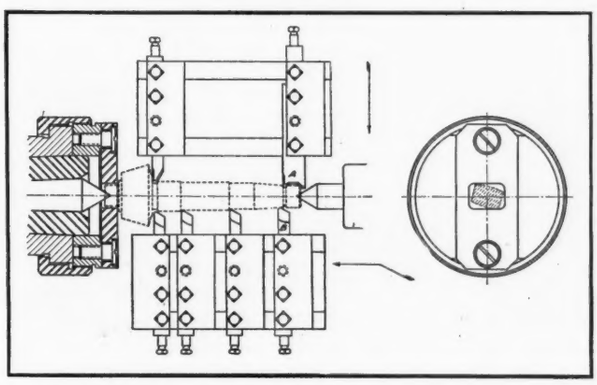


Fig. 1. Roughing Operation on the Shank of a Stem Bevel Gear

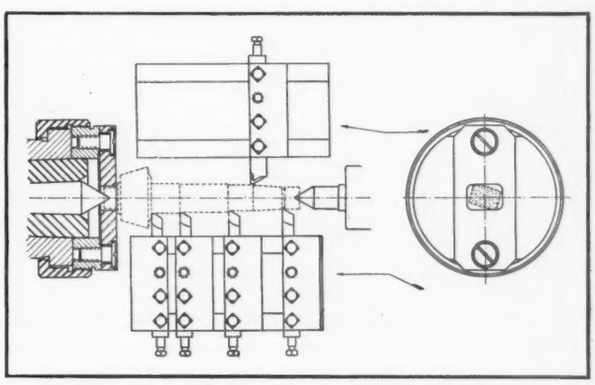


Fig. 2. Finishing the Shank of the Stem Bevel Gear shown in Fig. 1

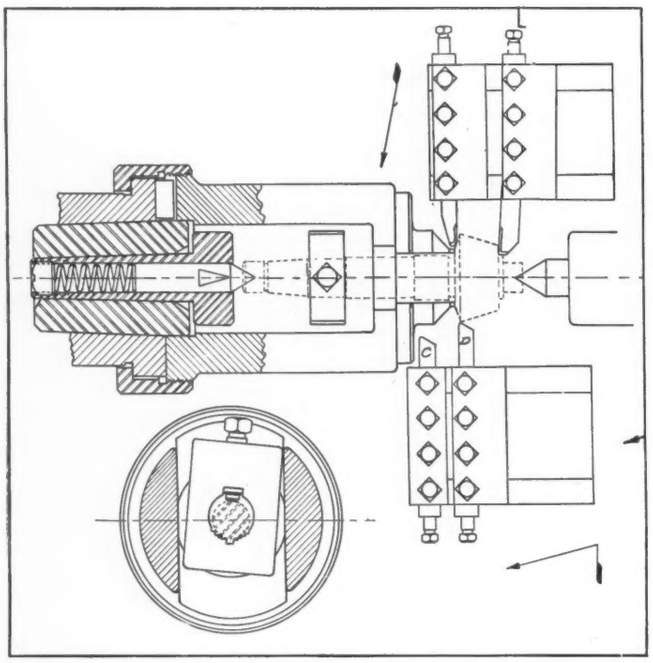


Fig. 3. Rough- and finish-turning and facing the Large End of the Stem Bevel Gear shown in Fig. 1

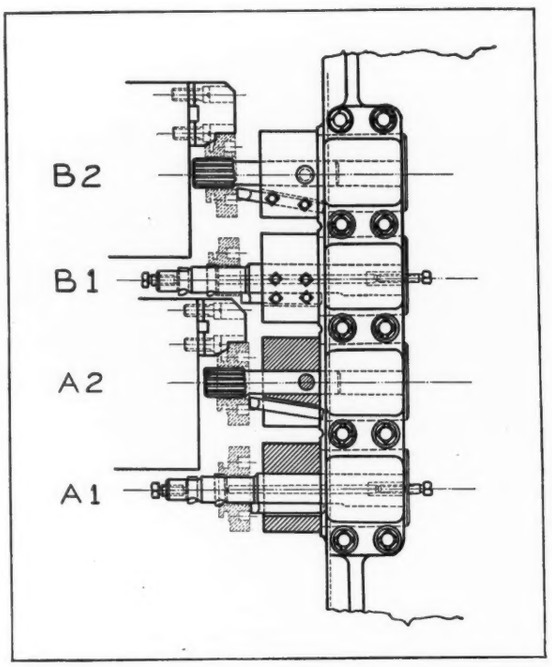


Fig. 4. Tooling Equipment for machining a Transmission Gear on a Double-spindle Production Lathe

automatic lathe, the turning tools on the front holder are relieved automatically on the return travel so that finished surfaces are not scored.

Finishing Two Gears Simultaneously

In the jobs described in the following, the work has a central hole which is finished first in a turret lathe or some similar machine, the finishing operations then being performed in a Fay automatic lathe with the work supported on an arbor. There are certain principles involved in the division of the cuts between two machines and the supporting of the work on an arbor; these are best illustrated by a simple case. In Fig. 7 is shown a job in which the holes in the blanks have been finished and the hubs faced in a preliminary operation. This operation is performed quickly, because the cutting is confined to a small diameter and done at high speed. The blank is held at the periphery so that a firm grip and a true running rim are obtained.

The standard arrangement illustrated in Fig. 7 consists of two machines, three arbors, and one operator. Then while one machine roughs the blanks on one arbor and the second machine finishes the blanks on the second arbor, the operator can change the work on the third arbor. It will be noted that the keyways have also been cut in the work prior to this operation, this provision permitting the heavy drive demanded by the intensive tooling. Simple rim-facing tools are supplied in the rear holder and rim-turning tools in the front holder.

This sequence of operations enables the work to be accurately machined, as it is supported on a true arbor mounted on true centers. The arbors are driven by a swiveling cross-pin, which balances cutting strains and eliminates any tendency of the arbor to spring. Furthermore, as the arbor has a heavy tapered male end supported in a hardened and ground bushing in the spindle nose, the stiffness of the spindle is brought directly into the arbor, and no long and yielding center intervenes. The following conditions give this method the maximum output: The simultaneous roughing and finishing of the work in two machines run by one operator; the simultaneous facing and turning of the work

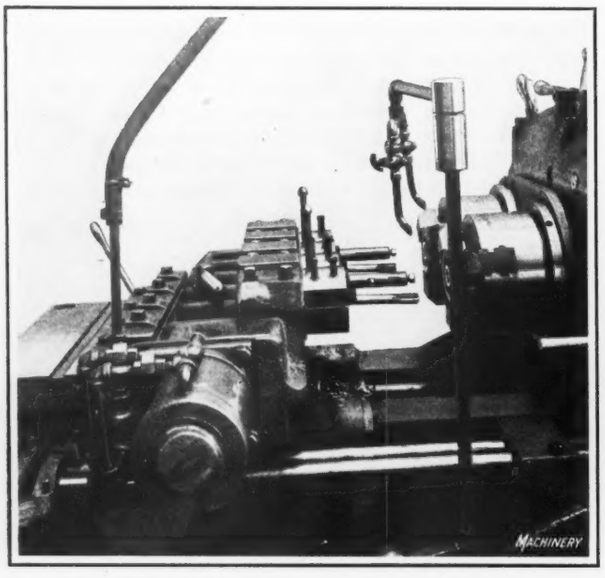


Fig. 5. Machine equipped with the Tool Set-up shown diagrammatically in Fig. 4

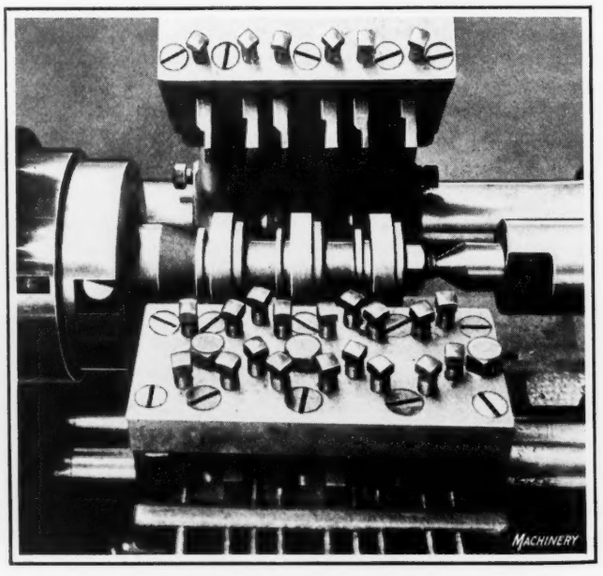


Fig. 6. Machining Three Transmission Gears at One Time by mounting them on an Arbor

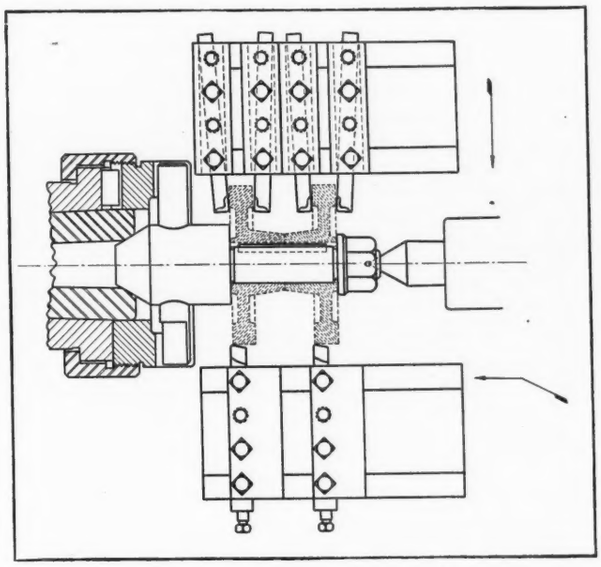


Fig. 7. Tooling Equipment for a Job in which Two Gears are finished at One Time

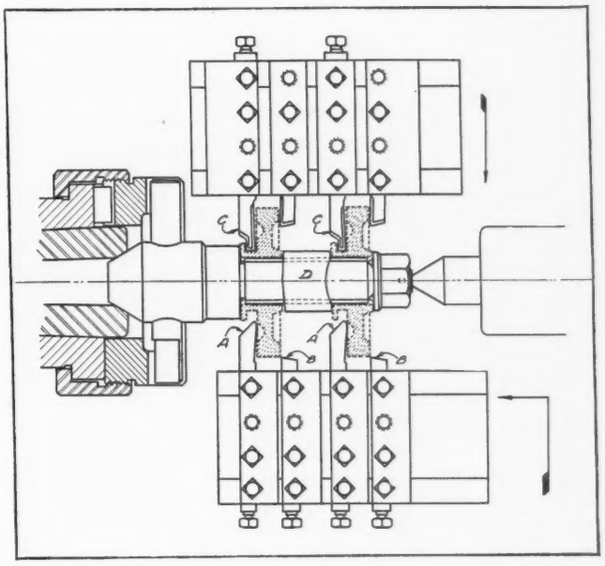


Fig. 8. Use of Spacing Collar to prevent Springing of Arbor when machining Two Gears at a Time

in each machine; the clamping of the work on the third arbor while the machines are in operation; the placing of the work between centers; and, finally, the mounting of two pieces at a time on each arbor, thus doubling the efficiency of the operation.

Tooling Equipments for Transmission Gears

The tooling employed in the production of sliding transmission gears is one of the most highly developed equipments used for machining automotive parts. Before the gears go to the double-spindle production lathe equipped with the tooling shown in Fig. 4, the rough forgings have the holes rough-drilled in a drilling machine. The work is held in the lathe by air chucks. The boring-bars in positions A1 and B1 carry roughing cutters which are immediately followed in the same feeding movement by finish-boring tools and rough butt-facing tools that machine the hub face. After the parts have been machined by these tools, the tools are withdrawn, the cross-slide automatically shifts, and the tools in positions A2 and B2 are brought up to the work. These tools finish-ream the holes and finish-face the hubs.

Fig. 5 shows a machine set up for this operation and gives a good idea of the construction of the automatically operated air slide. This machine is not classed as an automatic, but its results are comparable with those of a full automatic, because only a small effort is required of the workman. The operator runs two spindles, both of which are constantly under his observation, so that feeds and speeds may be used which would not be safe if he were tending a number of machines spread over a wide area.

The blanks now have the bore and one hub finished and are next sent to a broaching machine to be splined; in this operation the work is located against the finished hub. The facing of the opposite hub is next in order, and this is best done under a two-spindle drilling machine, which permits one spindle to be used for roughing and the other for finishing. The fixture used in this operation was shown in Fig. 3 of the article "Machining Automobile Transmission Gears" which appeared in March, 1920, MACHINERY.

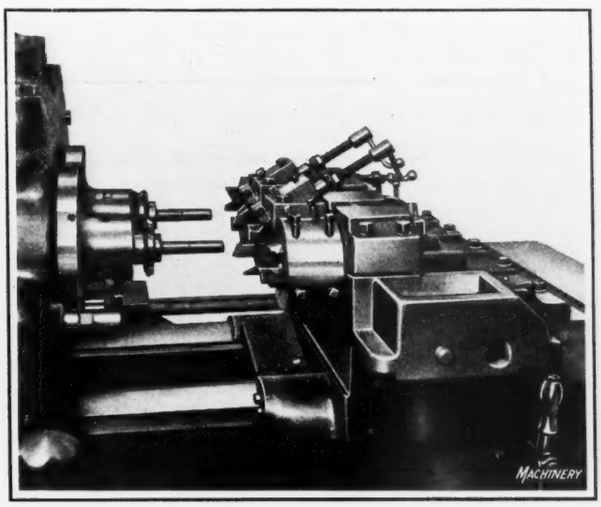


Fig. 9. Equipment for machining Differential Gears, Similar to that shown in Fig. 10 except that Hand-operated Recessing Tools are used

The next operation on the sliding transmission gears is performed in a Fay automatic lathe equipped with the tooling set-up shown in Fig. 8. Tools *A* first feed in radially and face the sides of the gears, and then feed toward the left and turn the fork flanges, while tools *B* turn the outside circumference. The rear holder, in the meantime, is also fed radially, but the grooving tools *C* do not come into contact with the work until after the scale has been removed by tools *A*. The finishing operation is similar, except that additional tools are provided where necessary to break corners and to obtain a finished job.

A somewhat more elaborate set-up for machining transmission gears on a Fay automatic lathe is illustrated in Fig. 6. It will be noted that while the arbor in Fig. 8 carries two gear blanks, the one on the machine in Fig. 6 carries three. It is seldom that the machining of three blanks at a time is practicable; usually only two may be handled satisfactorily, and sometimes only one.

The conditions that determine how many pieces can be handled at one time are as follows: First, the size of the hole in the work (which determines the slenderness of the arbor) relative to the outside diameter and the amount of metal to be removed. Second, the required accuracy of the hub length; if the tolerance is too large and three blanks are placed on an arbor, the outside blank may be considerably shifted from its normal position so that its rim is displaced with reference to the hub. Third, the construction of the arbor and the spacing collar. As no particular pains have been taken to face the outside hub of the gear true with the inside one or with the bore, the arbor is likely to spring somewhat when two blanks are clamped on it, and a great deal when three blanks are clamped on it.

A remedy for this condition lies in the construction of the arbor and particularly in that of the spacing collar *D*, Fig. 8. This collar fits loosely over the arbor and its splines and has a narrow

bearing against the opposing hubs of the gears, the bearing on one side of the collar being located 180 degrees from that on the opposite side. The collar thus has a solid seat against both hubs, whether they are true or not, and does not cramp itself, the arbor, or the work. By this means, the bending of an arbor is avoided. Of course, the same precautions must be taken in subsequent operations and especially in the cutting of the gear teeth. This is generally recognized, and tool designers usually arrange to clamp blanks by the rims so that the hubs have no influence on the truth of the arbor.

Production Lathe Set-ups for a Differential Gear

In the production of a differential gear, the work is first drilled and broached and then sent to a double-spindle production lathe provided with the tool set-up shown in Fig. 10. There are four double-ended arbors *B* supplied with each equipment, two of the arbors being used on the machine while the other two are having the work changed on them. These arbors drive the work by the splined hole and have bearings in hardened bushings, one of which is in the spindle fixture and the other in the cat-head tool-holder at the opposite end. An equalizing driving plate *C* keeps each arbor turning with the spindle, and spring *D* and the pressure of the cut hold the work back against the spindle fixture. When the tools are withdrawn, the arbor and work can be pulled out by hand.

The work is placed in the rear spindle and has one side roughed and finished by the two tool sets shown at the left-hand end of the plan view. The work is then withdrawn and inserted in the front spindle, where the other side is roughed and finished by the two tool sets shown at the right-hand end of the plan view. Both operations, of course, take place at the same time. A tool carried in the overhead fixture *E* cuts a recess on the work to facilitate the subsequent face- and cylindrical-grinding operations on the part. All other cuts are done by direct end cutting, and the tools for the different cuts can be readily identified by the legends on the illustration. The output of this machine for roughing and finishing both sides of the gears complete runs as high as thirty-six per hour for small gears. The set-up shown in Fig. 9 differs from the one in Fig. 10 only in that it is provided with simpler hand-operated recessing tools.

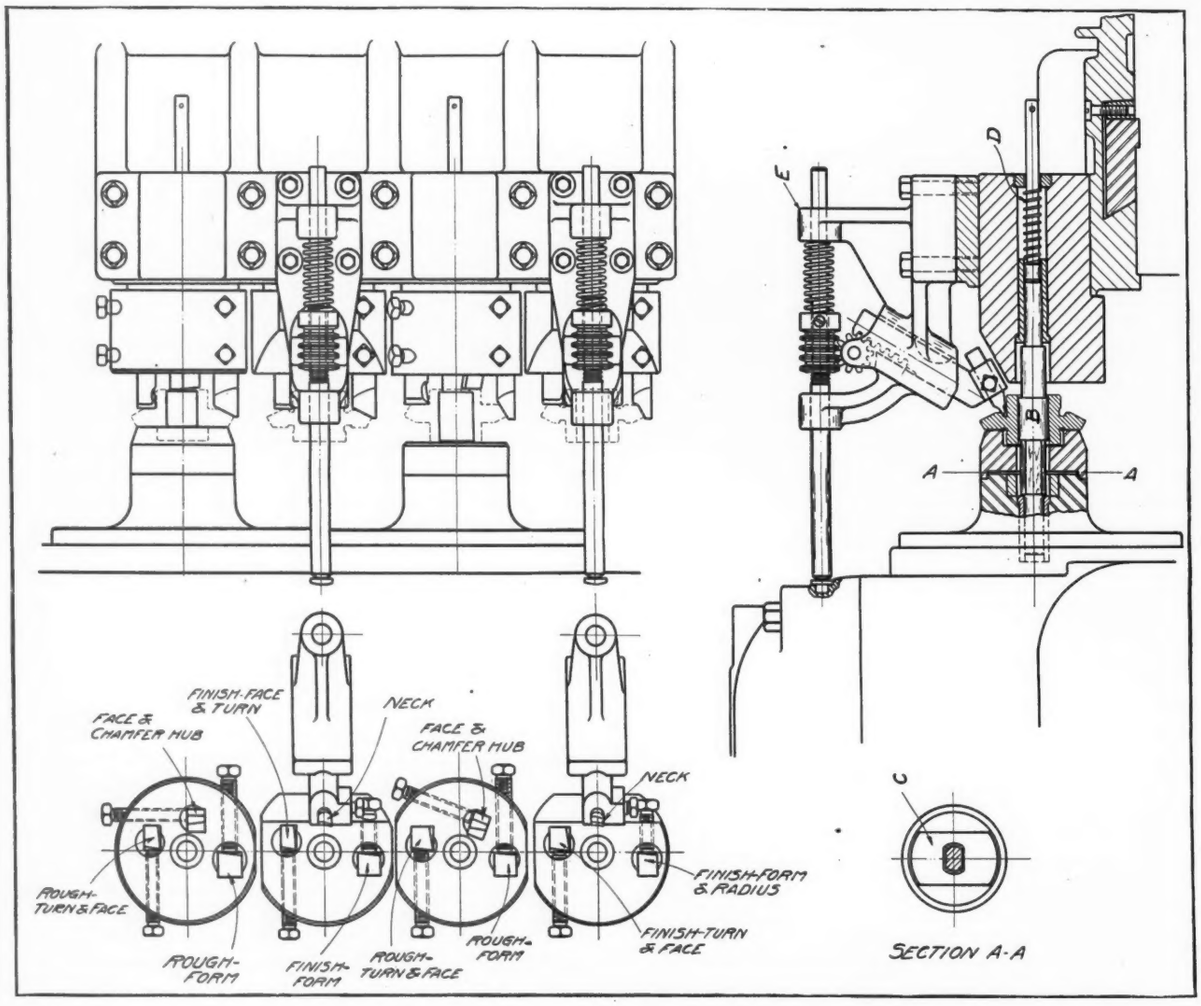
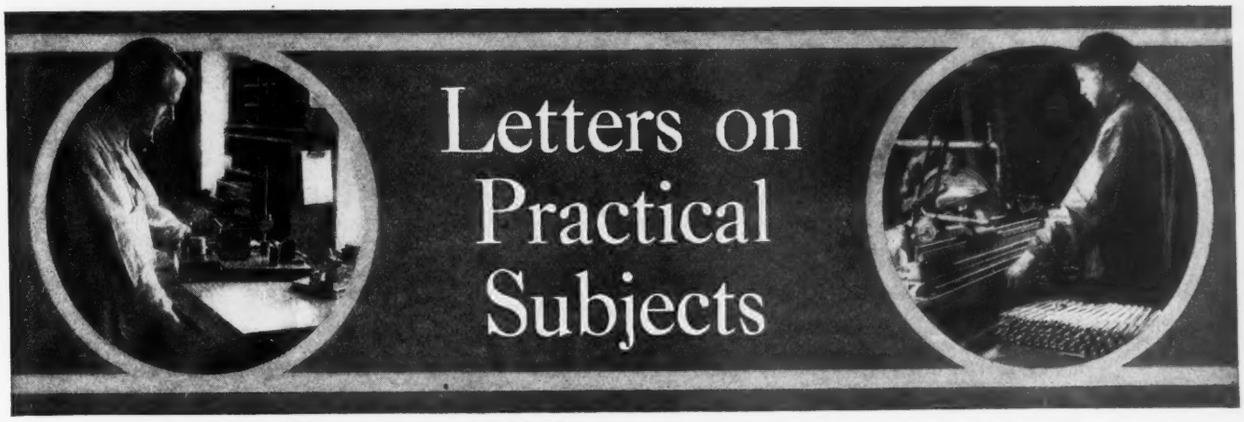


Fig. 10. Equipment supplied on a Double-spindle Production Lathe for machining Differential Gears

* * *

RAPID DRILLING OF NAMEPLATE HOLES

One of the jobs performed on a quantity basis in the plant of the General Electric Co. at Rochester, N. Y., is the drilling of nameplate holes in stators. In order to obtain a high rate of production on this job, a special-purpose two-spindle drilling machine is employed for this work, which was designed by the Leland-Gifford Co., Worcester, Mass. The machine is equipped with two spindles set at an angle in a horizontal plane, each of which is driven by an individual motor mounted on the spindle. The two spindles are operated simultaneously by a handwheel, which is placed between them and is connected with each by a universal joint, so that as the wheel is turned, the spindles feed at an angle corresponding to that of the nameplate pins. The stator is slipped over a horn in a jig, and by a single movement of the handwheel the two holes are rapidly drilled. The production time on this job, with an unskilled operator in attendance, is 10,000 nameplate holes a day, two holes each in 5000 nameplates.

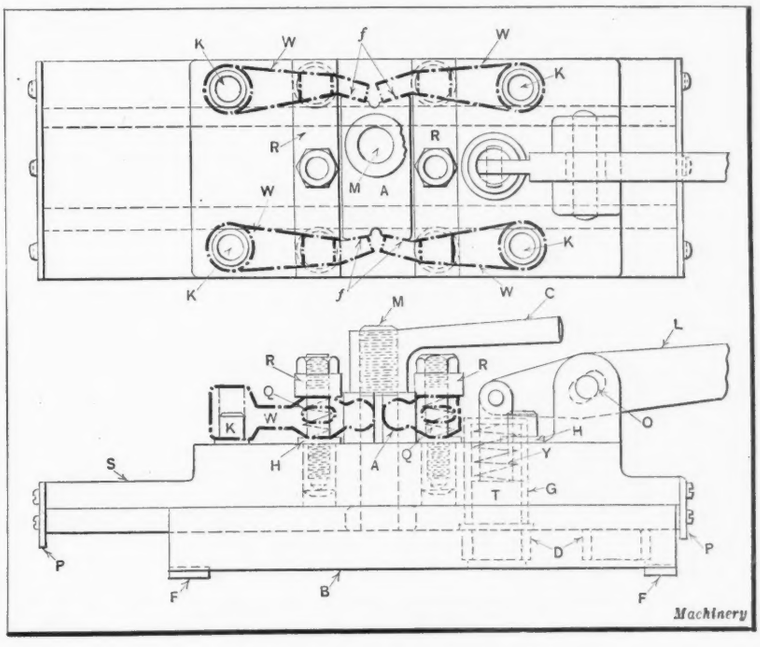


SPLINING FIXTURE FOR VALVE ROCKER ARMS

The fixture shown in the accompanying illustration was designed and built for the purpose of locating and holding valve rocker arms in a double-spindle automatic spline milling machine during the machining operation. The chief advantage of this fixture is that loading is performed while the machine is in operation and no time is lost, therefore, in putting in and taking out work. The table of the machine travels back and forth continuously while the cutters are fed into the work, backed out, and fed into the next piece of work automatically and without interruption.

Referring to the illustration, base *B* is grooved on its under side to receive two fixture keys *F*, which, in turn, fit into the T-slot in the bed or table of the spline miller, thus squaring up the sides of a female dovetail in the top of the base with the spindles of the machine. It should be understood that the machine spindles are located on each side of the table and would meet each other if sufficiently extended. Two screws (not shown in the illustration) are used to hold the base to the table of the machine. There are two holes in the base fitted with bushings *D*, which are counterbored so that the bushings do not come through the bottom of the base. A slide *S*, with a male dovetail, is fitted to the base and is prevented from sliding too far in either direction by two retaining plates *P*, each of which is fastened in place with three screws.

Before the slide is assembled to the base, however, it is necessary to insert the guide bushing *G* in the hole in the slide provided for that purpose and place the locating plunger *T* with spring *Y* in the guide bushing, connecting plunger *T* with lever *L* by means of a pin. Lever *L* is also pinned to the lug *O* on the slide. Four parts or pieces of the work *W* are shown by heavy dot-and-dash lines in the upper view, but for clearness only one complete part is shown in the lower view. It will be noted that the work is located at three points. The reamed hole in the piece fits over plugs *K*, which results in machining the spline square with the hole. A block *A*, centrally located, which is attached to the slide, has four hardened and ground angular surfaces *f*, which serve as stops for the free ends of the work. It will be seen that these surfaces locate the rocker arm in the correct angular position for cutting the spline.

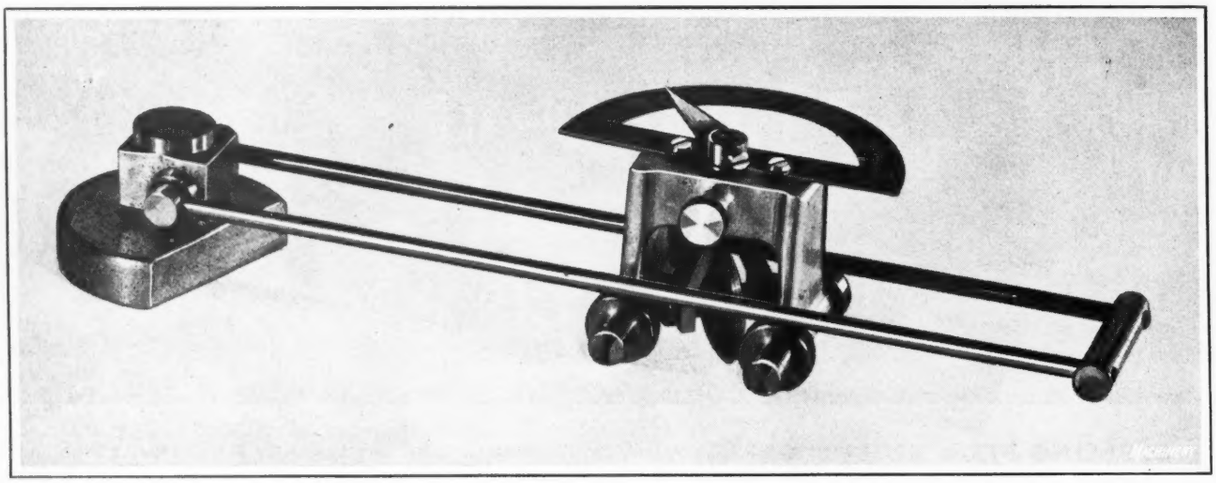


Splining Fixture for Valve Rocker Arms

The third locating point is governed by the distance from the top of the table to the center line of the spindles. The base and the slide are made sufficiently thick to bring the center of the work to the proper height when it rests on the hardened pins *H*. This distance must be accurate, but the dimensions of the slide and base may be made to the nearest even figure, and the exact distance can be obtained by increasing or decreasing the thickness of the head of the pins on which the work rests. The steel bars *R* are used to clamp and hold the work. A bolt and nut accomplishes this, the former being threaded into the slide. These bars are forced up by springs *Q*, as soon as the nut is loosened, and are prevented from turning by the block *A* which is fastened to the slide.

A heavy bolt with a large head, one side of which is beveled to correspond to the dovetail, is shown at *M*, and is placed in the slide so that it wedges against the side of the dovetail in the base when the clamp *C* is tightened. The main function of this clamping arrangement is to prevent chattering of the cutters, since the plunger *T* insures the correct location of the work with respect to the cutters. The spring on the plunger *T* counterbalances the weight of the handle or lever *L*. The lever *L* is provided with an elongated hole at *O* in order to avoid the use of a link.

When two pieces of work are clamped in the fixture in the two right-hand positions, the machine may be started. While these two parts are being splined the operator will have ample time to load several fixtures in succession and start each one going. Another pair of parts can then be loaded in each fixture by placing each over plugs *K*, at the left-hand end and swinging them against block *A*, holding them in with the fingers while tightening clamps *R*. When the first pair is finished, the cutters back out and the operator loosens clamp lever *C*, pushes down on lever *L*, and pushes the fixture slide to



Instrument designed to facilitate the Drawing of Logarithmic Spirals

the right allowing the plunger to drop into the other hole in the base. Clamp *C* is then tightened, and the next pair is brought in line with the cutters, ready for machining. The parts which have been machined can then be removed and two more blanks inserted. One man can operate a battery of several machines in this manner. B. S.

INSTRUMENT FOR USE IN DRAWING LOGARITHMIC SPIRALS

In the accompanying illustration is shown a device for tracing logarithmic spirals, which the writer made some time ago and which he believes possesses some advantages over the one described in August MACHINERY, page 1146. The design of this instrument is based on the fact that in a logarithmic spiral, radii to all points on the curve make the same angle with tangents to the curve at their extremities. The construction of the device is apparent from the illustration. It consists simply of a sharp-edged tracing wheel mounted in a slide which can move radially on an arm that is pivoted to swing about one end. When the tracing wheel is set at an angle other than 90 degrees to the arm, the slide will be drawn in or out as the arm is revolved about its pivoted end.

One advantage of this instrument is that spirals of any angle may be drawn in either direction, by simply adjusting the plane of the tracing wheel to whatever position is required, by means of the scale and pointer shown at the top of the slide. In case it is necessary to construct a curve outside the range of the instrument, it is only necessary to draw a spiral of the required angle, and then extend it by drawing several radii and dividing them internally or externally into some proportion that will carry the curve in or out as desired. A more complete description of the construction and operation of this device was published in the *Sibley Journal of Engineering* (Cornell University, Ithaca, N. Y.), April, 1920.

Niagara Falls, N. Y. HOWARD G. ALLEN

SIMPLIFYING DESIGN OF A WATER-COOLED JOURNAL BOX

In Fig. 1 is shown a water-cooled journal box made with a cored water circulating chamber at *A*. The metal between the chamber *A* and the bronze liner *B* is ¾ inch in thickness. When the box is cast, four small cores are employed to support the chamber core in the mold. The vents for carrying off the gases pass through the four cores which are located at the outer ends of the casting at *C*. After the casting has been cleaned, these cored holes are drilled and tapped. The two holes at the left-hand end are drilled and tapped to receive the water inlet and outlet pipes, respectively. The holes at the opposite or right-hand end of the casting are drilled and tapped to receive threaded plugs.

The bronze liner *B* is held in place on the water-cooled box by means of brass pins *D*. While a casting made in this manner may appear satisfactory and pass a critical examination of the outside surface, there is no assurance that the water cooling chamber is perfect or that the water can circulate through the chamber as intended. To overcome this objection a new box was designed which is shown in Fig. 2. The pattern for this cast-iron water-cooled journal box is easily made, and no cores, core-prints, or core-boxes are required. It will be noted that the water-cooling chamber is open or exposed. This enables the molder to inspect the mold thoroughly, and also enables a thorough inspection of the casting produced by the mold.

The open top cooling chamber is divided into narrow pockets or spaces *E* by dividing ribs *F*. There are four

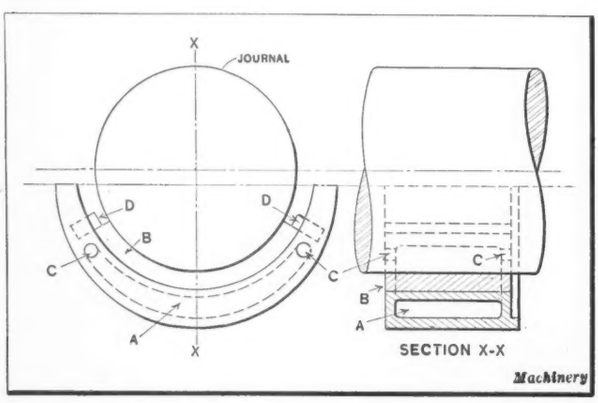


Fig. 1. Water-cooled Journal Box presenting Difficult Molding Problem

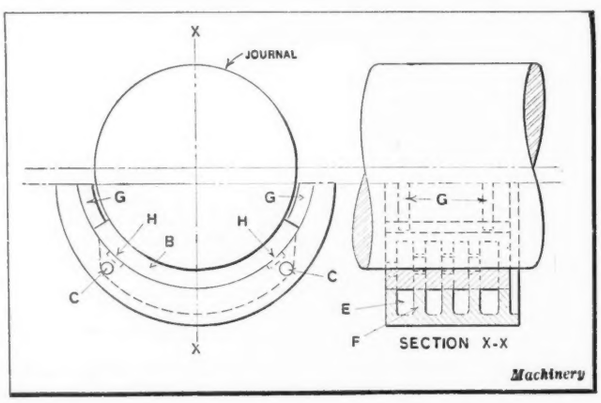


Fig. 2. Redesigned Journal Box which simplifies Molding Problem

stops *G* cast integral with the main casting. Two of these stops are located at each end of the casting. As these stops are in line with the pockets, it is possible to bore out the inside diameter or the supporting ribs *F*. The casting is, of course, finished all over. The bronze liner *B* covers the water chamber, and the water pipe connections are located to suit conditions. The ribs are cut out at *H* to permit proper circulation of the cooling water.

Kenosha, Wis. M. E. DUGGAN

DIAGRAM FOR DETERMINING RADII OF ELLIPSES

On complicated drawings it is frequently inconvenient to construct approximate ellipses by the methods given in engineering handbooks, because of the preliminary laying out involved in determining the radii required. By means of the accompanying diagram these radii can be determined readily and an approximate ellipse developed with little work. In using the chart, it is only necessary to know diameters *A* and *B*. Dividing these in two gives *a* and *b*, respectively. Corresponding radii of *R* and *r* are found by laying a straightedge across the known values of *a* and *b*. Assume that it is desired to find the radius required in constructing an ellipse of which *A* is 1 inch and *B* is ¾ inch. In this case *a* equals ½ inch and *b* equals ⅜ inch. By drawing a line connecting these values on the *a* and *b* scales as indicated by the dot-and-dash line, the value of *R* will be found on the *R* scale to be ⅝ inch, and *r* on the *r* scale to be 5/16 inch.

GEORGE L. HEDGES
Frankfort, Ind.

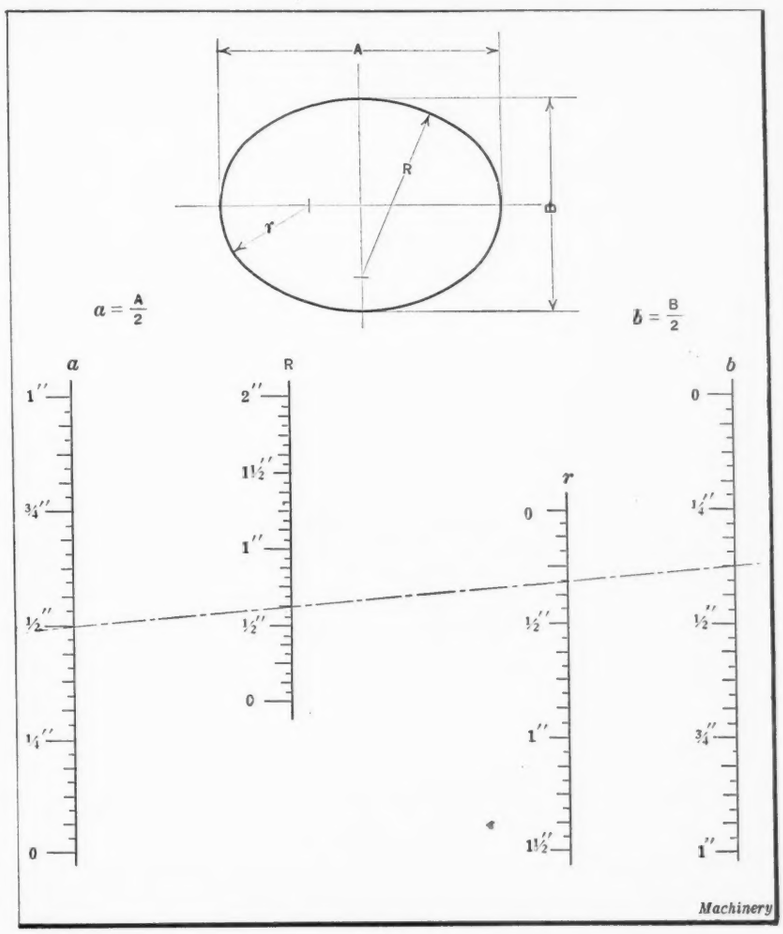


Diagram for rapidly obtaining Values required in constructing an Approximate Ellipse

A SIMPLE PATTERN NUMBERING SYSTEM

The plan for numbering patterns, explained in the following, has been found to have many advantages. The pattern number is composed of three distinct elements, or groups, each representing one of the three essential points to be considered in the identification of a pattern, namely, the kind of machine of which it is a part, the type or size of the machine, and the detail number which identifies the casting on the machine.

The number is so constructed as to contain as few digits as possible, and, at the same time, conform to all the requirements of the system. To this end both letters and figures are made to follow one another in a compact sequence, without the use of dashes or spaces, the letters of the alphabet being used in the first and last groups, and the figures placed between, forming the intermediate group. In this way a distinction of the three parts of the number is effected.

The first group indicates the kind, or general classification, of machine. The middle group gives the detail number of the part, and the last group represents the size or type, or both size and type of machine, which in such a case can be indicated by one symbol that is composed of one or two letters.

As an example, suppose a concern is manufacturing a line of engines and pumps. The engines would be in one classification, represented by a letter, such as A, and the pumps in another, represented by B, these letters being first in the sequence of the number. Suppose the cylinder head of the engine has the detail number 10, and the base of the pump 13. The size of the engine in the example may be represented by the letter A, and that of the pump by H. Then the number A10A would designate the cylinder head of a size A engine, and B13H the base of a size H pump.

The plan for assigning the detail numbers should be independent of that for all other numbers. The detail numbers should be taken from a list, in rotation, as the parts are placed on the drawings; thus 10 need not stand for the cylinder head for any other size or type than the one cited, since that one size or type may be very simple, with few parts, while another type may be elaborate in design and require a large variety of details. The letter indicating the kind of machine or product should be assigned at the time it is determined to make or design such a product, and should be taken in its turn from a list. The letters for the size or type should be assigned in a similar way, and a separate list of letters for sizes belonging to each general class or kind should be kept distinct from all other classifications; thus "A" representing a size of engines should have no relation to "A" in sizes of pumps.

If the products of the concern should increase so as to cover many classes and types of machines, it might be necessary to use two letters, either for classification or for size, and if the details of one machine run higher than ninety-nine, in number, it would be necessary to use three figures. The longest pattern number that is likely to occur under this system, however, would contain seven characters, such as AA107AB, but even such a case would be extremely rare. It is not likely that there would be over one letter in the end groups, or two figures in the middle, in most cases, making four altogether, which is as compact as it can usually be made.

There are some letters that are objectionable for use on patterns, when used in connection with figures, for the following reasons: The letter O is identical with the zero of the numerals, and the letter I can hardly be distinguished from the figure one. The letter C could be made from O if a portion of the side should be washed out in the mold, and a portion of the letter Q could be washed out in a similar manner and made to look like O or C. If the lower portion of E were washed out it would look like F, and if A were shown indistinctly, and were read upside down, as is often the case on a casting, it might be taken for V. By eliminating all such objectionable letters, and having it known that the system does not contain them, there would be no chance of mistaking one for another. The letters to be eliminated would then be C, F, I, O, Q, and V, there being six in all, and that would leave twenty to be used, which are, A, B, D, E, G, H, J, K, L, M, N, P, R, S, T, U, W, X, Y, and Z.

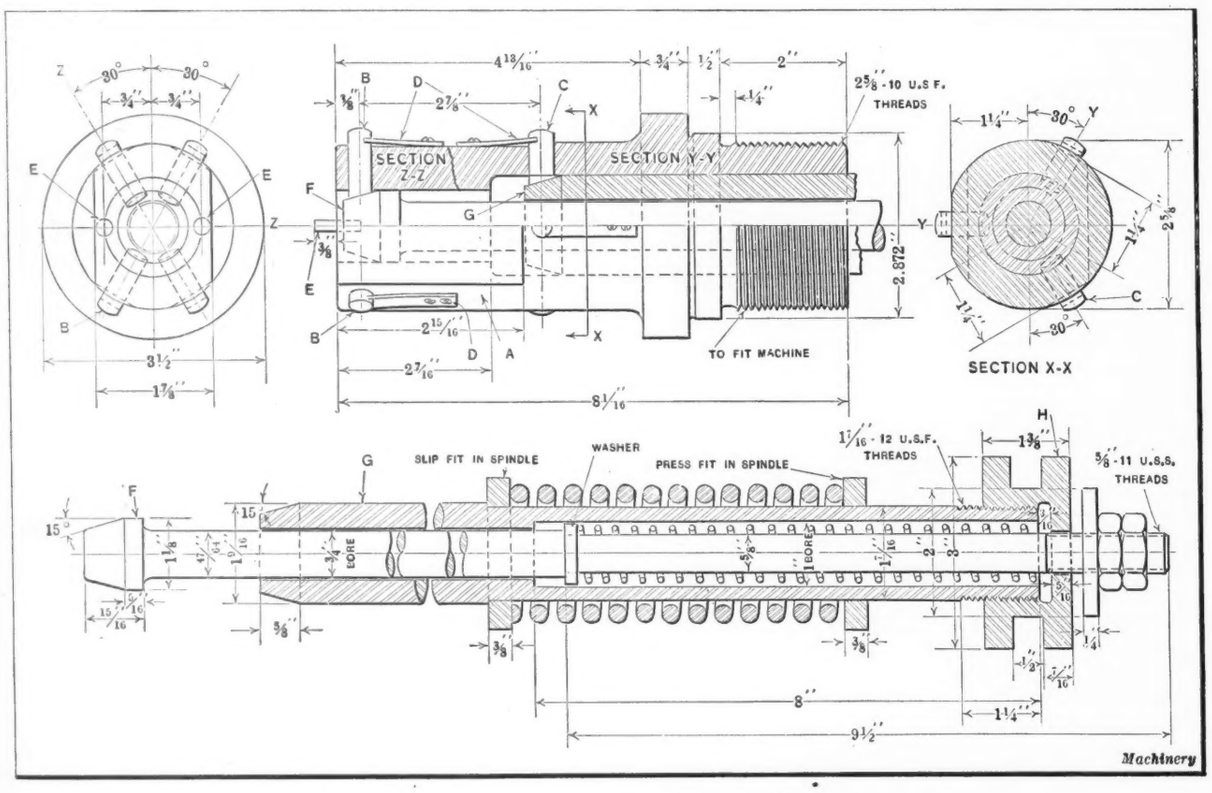
These twenty letters, if used in combination like numbers, would form a double decimal system giving a combination of 399 numbers where two letters are employed, which would more than take care of the needs of any concern. The twenty letters would usually be sufficient for all needs.

North Judson, Ind. WILLIAM H. KELLOGG

PISTON CHUCK

The writer has noted with considerable interest the various designs of devices for chucking pistons from the inside while rough-turning the outside surfaces. The best results are obtained by chucking pistons in this manner; however, nearly all manually operated chucks designed for this purpose require the use of wrenches, and consequently result in increasing production costs. In the accompanying illustration is shown a type of piston chuck that does not require the use of wrenches and that can be operated by one lever.

The body of the chuck with the various operating parts assembled is shown in the upper half of the illustration, while in the lower half a sectional view of the actuating arrangement for the two plungers is shown. The machine-steel body *A* has flats milled on each side to a width which will permit it to fit between the wrist-pin bosses on the inside of the piston and thereby act as a driver. There are four hardened tool-steel pins *B* carried in the outer end of the body to accommodate the nose of one plunger, and three similar pins *C* operated by the nose of the other plunger. These two sets of pins are held in place and moved radially inward by flat springs *D*. Two pins *E* projecting from the end of the body act as stops against the closed end of the piston and take up the end thrust of the cutting tool.



End and Sectional Views of Piston Chuck and its Actuating Mechanism

The plungers *F* and *G* are actuated by coil springs. The chuck is operated by a lever with a forked end, located at the rear of the machine above the spindle, which engages collar *H*. Movement of this lever is all that is required to operate the two plungers by means of which the piston is chucked. When the lever is moved to the right, the pins *B* and *C* are drawn in to permit the piston to be slipped over them preparatory to chucking. When the lever is released, the springs force the plungers to the left, thereby expanding the pins and securely chucking the pistons in place. An air chuck could be substituted for the larger spring, but if the proper springs are used, a hand-lever will be found satisfactory. This type of chuck has been used to chuck pistons when taking cuts that were as much as ½ inch eccentric.

Chicago, Ill. HAROLD A. PETERS

WINDING COIL SPRINGS

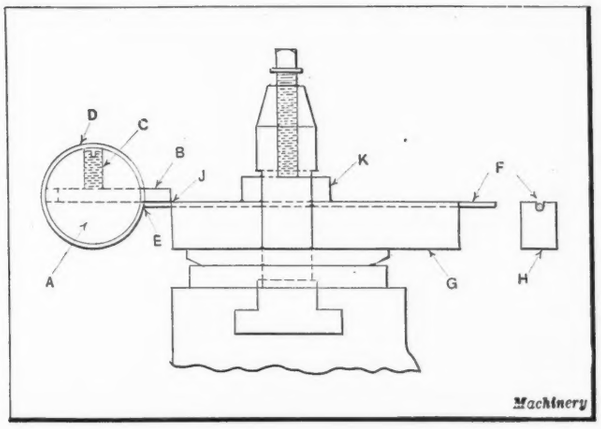
The following is a simple method of winding a coil spring. A piece of steel tube or pipe about 6 inches long with a ½-inch or ⅜-inch hole is fastened in the toolpost of the lathe, using a boring-bar vee to secure rigidity. The wire is passed through this tube, and the end gripped in the chuck or dog of the arbor on which the spring is to be wound. The lathe is geared to the pitch of the coil wanted, or in the case of the closed coil spring, it may be geared for a pitch slightly less than the number of coils per inch. In using this device, the end of the tool through which the wire is fed should be as close as possible to the winding arbor.

New Britain, Conn. W. C. BETZ

CUTTING RIVETS IN THE LATHE

As about 6000 rivets, 1/16 inch in diameter, were required and nothing better than a hand shear was available for cutting the rivets from wire stock, it was decided to equip a lathe for the wire-cutting operation. The accompanying illustration shows how this was accomplished. An ordinary milling machine boring-bar *A* was set up in the lathe and a 5/16-inch tool bit *B*, ground on the face and end, was fastened in the boring-bar by a set-screw *C*, as indicated. Next, a piece of 1/16- by ½-inch cold-rolled steel was bent around a piece of shafting slightly smaller than the boring-bar in order to form a sleeve *D* which could be sprung on bar *A* to cover the back end of the tool recess and the set-screw hole. This sleeve formed a smooth surfaced stop for the end of the wire stock *F* which makes contact with it at *E*.

The high-speed steel lathe tool *G* was then ground smooth on its top surface and on one end. A groove was cut the full length of tool *G* on its top surface as indicated in the end view at *H*. This groove was made slightly larger than the wire except at the cutting edge *J* where it conforms to the size of the wire used for the rivets. The tool was fastened in the toolpost with a steel block *K* on its top surface to keep the wire in the groove while it is being fed forward. In operation, the cutting edge of the tool bit in the boring-bar is set a certain distance from the face of sleeve *D*, according to the length of the rivets or pins required.



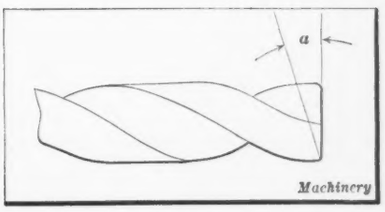
Lathe Equipment for cutting Rivets

The cutting edge of the lathe tool at *J* is fed up until it will just cut thin paper when the arbor is rotated. The carriage and the tailstock are then clamped tightly in place. The lathe can be run at a fairly high speed, depending upon the size of stock to be cut. The highest speed obtainable with an open belt was used in cutting the 1/16-inch wire. The wire is fed through under constant tension, and should jump forward and strike the stop sleeve *D* as each piece is cut off. With this arrangement 3000 rivets were cut within five minutes.

East Walpole, Mass. JAMES A. KIRK

USING A TWIST DRILL FOR AN END-MILL

The following describes a method that was employed for finishing a thin-walled core-box which was comparatively deep. The corners forming the sides of the box were joined with a 3/16-inch radius, and the bottom was filleted to the sides with a 1/16-inch radius. Ordinarily a ⅜-inch end-mill would have been used, but on account of the depth of the box such a tool could not be conveniently employed. Consequently, a ⅜-inch twist drill was especially ground in the manner shown in the accompanying illustration. The lips of the drill were ground with suitable clearance, but the cutting edges were produced nearly flat, as is sometimes done for bottoming a hole. A 1/6-inch radius was ground at the outer corners of the lips, to suit the fillets at the bottom of the box. The box had previously been planed so that it would seat evenly on the table of a drilling machine, where the finishing of the interior was accomplished. The drill was set to depth by the regular stop on the machine spindle, and was fed down to this stop in the course of routing out the metal. By moving the box around under the drill on the table, the operation was completed without difficulty.



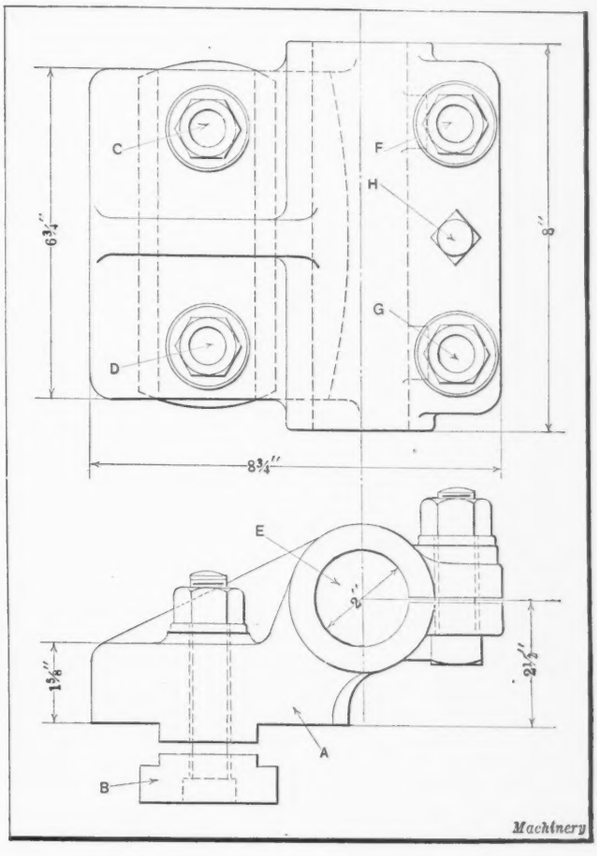
Twist Drill ground to serve as an End-mill

Since using the drill on this job, it has also been employed on a number of occasions for removing lumps and excess metal in core-boxes. It has been found that if proper care is taken in grinding, the drill will work easily and cut smoothly, and will not chatter nor gouge into the work. The angle *a* should not be greater than is necessary to provide clearance, and the center should be just a little above the two cutting edges of the drill. If the center is ground much above the edges of the drill, it will be found that the drill will cut freer, but it will not produce a smooth surface. It is not to be expected that a drill ground in this manner can be used in place of an end-mill in all cases, but in an emergency a tool of this kind will bridge over the difficulty very well.

Detroit, Mich. NELSON HALL

BORING-BAR HOLDER

The accompanying illustration shows one of a number of similarly designed boring-bar holders, intended for fast, heavy cutting on comparatively large work, such as big gears, sheaves, and large piston-ring castings of the pot type. The holder shown is used on a 24-inch gap-bed lathe, which



Boring-bar Holder for Heavy Cutting on Large Work

has a swing of 48 inches when the gap is open. The cast-iron holder *A* and the steel slide *B* are made with tongues that are a snug fit in the tool-rest. When in use, the holder is clamped tightly down to the tool-rest by means of the two ¾-inch bolts *C* and *D*. The 2-inch boring-bar is a sliding fit in the reamed hole *E* of the holder, and is securely clamped by the two bolts *F* and *G*, located in the projecting ears.

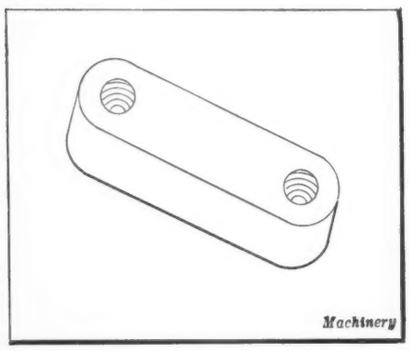
The upper ear is tapped for a ¾-inch set-screw *H*, which is used as a jack to loosen the grip of the holder when it is necessary to remove the boring-bar. When a bar smaller than 2 inches in diameter must be used, a split cast-iron sleeve is slipped over the bar, and both bar and sleeve are clamped in the holder. This design of holder has proved satisfactory for general maintenance work requiring accurate boring at high speeds and feeds. The holder and the boring-bar used with it are more rigid and have greater bearing surfaces than are ordinarily found in commercial holders.

Baltimore, Md. WILLIAM L. HAMPSHIRE

REMOVING KEYS FROM KEYSEATS

The width of a keyseat in small diameter shafts is usually given a tolerance of 0.001 inch, limiting the maximum width to the standard dimension, and the minimum width to 0.001 inch smaller than the standard dimension. The width of the key usually varies from the standard size to 0.001 inch large. It is possible, therefore, for a man, working within these limits, to take an allowance of the extremes in both cases and give to the key a force fit of 0.002 inch. To remove from a shaft any key having a forced fit is a difficult job, and very often an attempt to do so results in spoiling the key.

The ordinary practice is to tilt one end of the key up above the keyway by means of quick, sharp blows, using a chisel and hammer for the purpose, and then pry the key from its seat with a screwdriver. Even when extreme care is used, a badly marred key usually results. Another common method is to hold the key in a vise and tap the shaft with a lead hammer. These methods may appear crude, but nevertheless they represent common practice.



Key provided with Tapped Holes to facilitate Removal from Seat

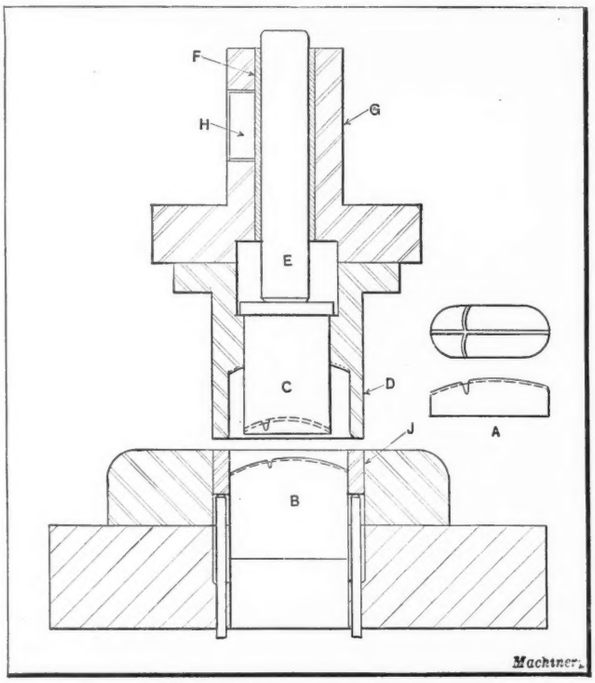
The illustration shows a key provided with two tapped holes. The removal of such a key is a simple matter, because all that is required to extract it is the insertion of two standard screws and the use of a screwdriver. The screws used in this manner are in reality miniature jack-screws. If the tapped hole projects into the shaft the threads on the ends of the screws that go into the shaft should, of course, be removed.

R. J. S.

FRICTION PAD FOR DRAWING DIE

The combination blanking and drawing die shown in the accompanying illustration is used on a single-action press to produce small shells of the shape shown at *A*. Considerable trouble was experienced in drawing these shells until the friction pressure-pad *C* was incorporated in the die. Before the pressure-pad was used, many pieces were spoiled from the slipping of the blank on the forming punch *B* during the drawing operation. The friction pad *C*, which entirely eliminated this trouble, is fitted in the combination blanking and forming punch *D* as shown. The hardened tool-steel pin *E*, in contact with pad *C*, is fitted in a hard fiber collar *F* which is held tightly in holder *G*. A tool-steel block *H* is set in a slot in punch-holder *G* so that it is located under a heavy set-screw in the ram of the press.

When the die is in operation, the set-screw in the press ram is screwed up fairly tight against block *H*. It should be adjusted until the proper amount of friction is obtained as determined by trial. As the ram descends, pad *C* comes against the blank as soon as it has been cut, and the friction between *E* and *F*, caused by the tightening of the screw on block *H*, is sufficient to emboss the grooves in the metal, thereby locating the piece and holding it firmly during the forming process. At the end of the downward stroke, the



Combination Blanking and Drawing Die

pad *C* is, of course, flush with the inside of the forming punch *D* and remains there until the top of the stroke, when the pin *E* is pushed down again by the knock-out of the press, which causes the shell to be ejected from the punch. This friction device, of course, takes the place of the spring which is commonly used for such work; a spring cannot be used in this case as the pressure would be maintained during the up stroke and the thin shell would therefore be crushed between pad *C* and pressure ring *J*. This die has been in use for some time, and has given satisfactory results.

East Orange, N. J. W. B. GREENLEAF

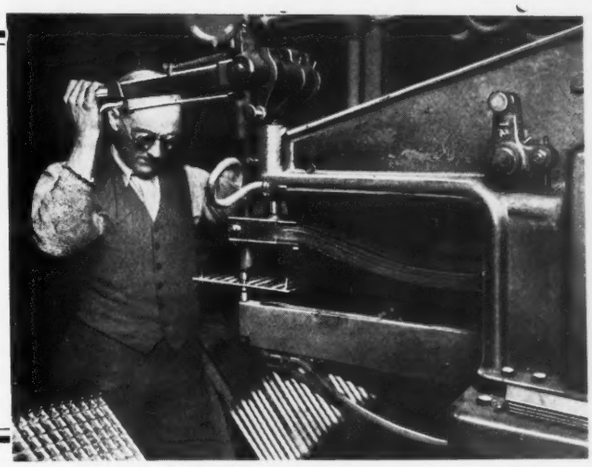
* * *

STEAM TURBINE LOCOMOTIVE

A locomotive has been put in service on the Swiss Federal Railways which is provided with a steam turbine and condensing plant. The engine is designed and constructed by the Swiss Locomotive & Machine Works, Winterthur. The locomotive frames carry the boiler in the usual way, and the steam turbine is placed in front on the smokebox. The turbine drives, through double spur gearing, a jack-shaft placed across the frame, which, in turn, transmits the power to the driving wheels. The surface condenser is placed between the frames under the boiler, the simplification of the mechanism, due to the use of the turbine, making this space available. The condensing water is cooled by the current of air produced by the movement of the locomotive. In the trial runs that have been made in ordinary railway service, the arrangement has proved successful, and considerable economy is expected from the design.

Reducing Costs by Electric Welding

Specific Examples of Savings Effected in a Number of Industries by the Use of the Electric Welding Process



THE electric welding process has been developed during the last ten years to a point where instead of being an unusual method, it is now commonly employed in the manufacture of a great number of devices and appliances. The following article gives details relating to the application of electric welding in metal-working plants using machines built by the Winfield Electric Welding Machine Co., and the Taylor Welder Co., both of Warren, Ohio. The data are presented in order to bring to the attention of manufacturers generally what has already been accomplished in securing economy and reducing costs by electric welding —a method which should be investigated whenever production work is contemplated for which the process would prove suitable. In the following, the data relating to each class of manufacture are given briefly and concisely, as a record of performance.

Electric Welding in Automobile Work

A manufacturer of sheet-metal parts for automobiles, trucks, and tractors in the Middle West uses the electric welding process for materials of a thickness from ¼ inch down to No. 24 gage. On account of the variety of parts welded, it is difficult to state specifically the number of welding operations performed per hour, but on ordinary flat pieces requiring five or six welds, this company averages about 200 pieces per hour. The estimated increase in production as compared with the riveting process on this class of work is from 100 to 150 per cent.

In another plant, ¼-inch soft cold-rolled steel is welded, four welds being made in each piece. As compared with the old method of performing this work, the saving is approximately $40 per 1000 pieces, and the production has been increased from 12 to 70 pieces per hour.

Welding Metal Furniture and Metal Doors

One plant making fireproof metal cabinets employs five welding machines for welding sheet steel of from 10 to 28 gage. In this plant electric welding has been applied for ten years, and riveting operations have been practically eliminated except in cases where it is considered impracticable to use a weld. Compared with riveting, however, it is estimated that the increase in production by electric welding is something like 500 per cent, and the company states that even this figure may be considered conservative. On the average work in this plant, sixty welding operations per minute are easily performed.

In another metal furniture plant parts of from 10 to 24 gage are welded at the rate of from 100 to 200 parts per hour. In this case practically all the assembling work is done by welding. The estimated saving in the cost of production is 50 per cent and, at the same time, the rate of production is increased about 50 per cent.

A well-known manufacturer of hollow metal doors and trimmed metal moldings and shapes, stampings, and various other metal specialties, employs both the butt-welding and spot-welding processes. The welding material ranges from 14 to 22 gage and varies in width from 2 to 10 inches. A material saving in cost is shown, and the estimated increase in production ranges from 25 to 500 per cent over methods formerly used, according to the particular operation performed.

Welding Foundry Supply Material

An Ohio manufacturer employs the electric welding process for double chaplets and plate-fitted chaplets, such as are used in foundry work. In making up the double-head chaplet, a plate is welded on each end of a round stem in one operation. On the plate-fitted chaplet, a single plate is welded to a stem in one operation. Stems 3/16 inch in diameter and plates of 18 and 20 gage are successfully welded by these processes, these dimensions being the minimum for which the machine is used. It is employed for either type of chaplet having stems up to ⅝ inch in diameter, with either ⅛-inch or 3/16-inch plate. The smaller sizes mentioned are welded at the rate of from 300 to 350 per hour, while the heavier sizes vary with the diameter and length of the stem.

Welding Curb and Gutter Rails

Another Ohio manufacturer making curb and gutter rails uses a spot-welding machine for welding the sleeves and reinforcing cleats to these rails. The material used is Nos. 10 and 11 gage. It has been found that 100 6-inch rails may be welded per hour, there being fourteen spots on each rail. At this rate of welding, the time required for placing the sleeves and cleats previous to welding is included. There is a saving effected in the cost of material, as compared with riveting, of 10 cents per rail, and the increase in production, which is the biggest factor, amounts to about 75 per cent.

Use of Electric Welding in the Manufacture of Household Utilities and Toys

A manufacturer in New York employs the electric welding process for welding operations on household utilities, such as wire soap-dishes and bathroom fixtures. The sizes of wire mostly welded range from 1/16 to 3/16 inch, and in this case each machine used welds approximately from 63,000 to 65,000 welds per day. As an indication of the reliability of the electric welding machine in its present state of development, this manufacturer mentions that for the last six years the cost of repairs on his machines has been negligible.

A New England manufacturer of children's play wagons uses electric welding machines for the welds on wheels and other metal parts, using principally black sheet and band iron and some light channel iron. The number of welds per hour for the different sizes of wheels vary from 150 to 300. This manufacturer states that while the saving in the cost of material is merely that of rivets, this item in the course of a year would amount to the cost of two welding machines. The saving in labor cost over the riveting method is estimated to be about double that of the saving on rivets.

The Metal-working Industries

DURING the last three months there has been improvement, although slight, in the machine tool industry. December is usually a quiet month in the machinery business, and as this year is no exception, the improvement noted goes back to the months of October and November. The improvement has not been uniform; generally there has been less demand for heavy machine tools than for the medium and small sizes. The demand has been more for the standard lines—especially the medium and low-priced types—than for automatic or high-production machinery. A few exceptions are noted, one of the leading builders of heavy machine tools reporting some very good sales. There has been only a limited amount of railroad buying, and the best trade has been in small machines for trade school use and for repair work. One builder, devoting himself exclusively to trade school machines, has been running at 50 per cent capacity during the entire year without adding to his stock.

Activity in the Small Tool Business

By comparison, the small tool business is very much better than the machine tool business at the present time. Whenever the metal-working shops begin to be active, even to a limited extent, they must have small tools—taps, dies, reamers, milling cutters, drills, etc., whereas they need not add to their machine tool equipment until they have reached capacity production. There has been a surplus stock of drills on the market during the past year, but the stock of other small tools in the hands of users and dealers appears to be exhausted, and one manufacturer of small tools is now operating at 45 per cent capacity, with present indications in the trade pointing toward 55 or 60 per cent within another month. Another of the leading makers of small tools is running at 40 per cent capacity, without adding to his stock. The hardware plants are among the best customers at the present time for tools of this kind, as many of the leading hardware factories are fully occupied. This, in turn, would indicate that there is expectation of increased building activity next year, which, if it materializes, would react favorably on all lines of business.

Machine Tool Prices

The substantial reductions in machine tool prices during the past year were made possible by reductions in pig iron, castings, and steel, brass and bronze, and also by reductions in wages, but there are many costs entering into machine tool building that have not come down, notably freight rates and taxes. The higher cost of transportation has increased the selling expense to a point where it is greater than ever before. While the increased cost of selling is due to many factors, high passenger fares and the higher cost of hotel accommodations are important items. In neither of these costs is there much prospect of any immediate or material reduction. These expenses become a permanent addition to the selling price, because they are definite factors that increase costs.

In the special machinery field and in the manufacture of parts as well as in jobbing work, competition is very keen—in some cases almost ruinous. In the parts manufacturing field, purchasing agents have been taking advantage of present conditions in the industry to force quotations so low that the seller loses instead of making a margin of profit; and sometimes the methods employed to get the lower prices would not stand the test of good business ethics. Some of the parts manufacturers, naturally anxious to get work for their idle plants, have too eagerly played into the hands of the purchasing agent.

A number of machine tool builders are partially occupied on contract work for machinery and devices outside of the machine tool field. In some cases it is likely that the plants will be permanently occupied on such work in addition to the regular machine tool business. In this way the excess capacity of some of the machine tool building plants will eventually be absorbed. There have been consolidations in the machine tool field also, and shops have been dismantled and added to the plants of other companies controlled by the same financial interests.

Perhaps the most serious factor in the machine tool field at the present time is the large stocks on hand. Even if buying should be fairly brisk within the next few months, it would be quite some time before the shops could run at anywhere near capacity. Foreign trade presents a new problem in the machine tool field, where 25 per cent of the production usually has been disposed of abroad. In some lines over 50 per cent of the business in pre-war years was foreign. Now the European trade has been reduced to almost nothing, and only the trade with Australia, Japan, China, and India—a comparatively small trade at best—is normal. There has been a fair trade with South America during the past year, but competition in the South American field with British and German machinery is very keen. The total foreign trade in machine tools during the month of October, the last month for which the Department of Commerce has issued complete detailed statistics, was only about 15 per cent of the trade early in 1920.

The Iron and Steel Industry

The iron and steel industry—the barometer for the entire metal-working field—is steadily though slowly improving. The average operation of the steel mills is from 40 to 45 per cent, but the November output was the largest of the year. There have been further price concessions, and a considerable agitation for lower freight rates; even though prices at base points may not be reduced further, lower freight rates would enable the consumer of iron and steel to obtain his raw materials at a considerable reduction, because freight rates are a very important item in the price of pig iron and steel at points removed from the iron-producing districts.

The Railroad Situation

It is estimated that the railroads will save $50,000,000 a year by the application of the revised working rules governing railroad shop employes, accepted by the United States Railroad Labor Board, which went into effect December 1. According to these new rules, the open shop principle is recognized on all railroads, and members of certain crafts are permitted to do minor jobs previously required to be done by members of other crafts. The new rules supplant the National Agreement made during Federal control of the railroads, and constitute one of the most important advances in restoring efficiency in railroad operation.

On account of the hampering influence of the unions, a number of railroads are understood to be considering leasing their repair work to outside shops. The Erie and the New York Central railroads have already had some of their repair work done in this manner, and it is stated that a considerable saving has been the result.

The net earnings for the month of October, the last month for which complete figures are available, show the highest increase for the year, and it is confidently expected that the railroads will soon be in the market for new equipment—both rolling stock and machine tools.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

Fellows High-speed Gear Shaper. Fellows Gear Shaper Co., Springfield, Vt. 407
Barber-Colman Automatic Hob Sharpening Machine. Barber-Colman Co., Rockford, Ill. 409
Gleason 4-inch Spiral Bevel Gear Generator. Gleason Works, Rochester, N. Y. 411
Universal "Tri-way" Horizontal Boring Machine. Universal Boring Machine Co., Hudson, Mass. 413
Bryant Wrist-pin Hole Grinding Machine. Bryant Chucking Grinder Co., Springfield, Vt. 413
Gordon Crankshaft-Cheek Turning Lathe. Willard Machine Tool Co., A St., Box 784, Cincinnati, Ohio 415
Precision Wheel Truing Head. Precision & Thread Grinder Mfg. Co., 1 S. 21st St., Philadelphia, Pa. 416
Noble & Westbrook Tube Marking Machine. Noble & Westbrook Mfg. Co., 19 Asylum St., Hartford, Conn. 416
Blomquist-Eck Pneumatic Riveting Machine. Blomquist-Eck Machine Co., 1146 E. 152nd St., Cleveland, Ohio 416
Natisch Geared Speed Transformer. Natisch Gear Works, 451 Hudson Ave., Brooklyn, N. Y. 417
General Electric Direct-connected Planer Drive. General Electric Co., Schenectady, N. Y. 417
Sellew Automatic Drilling Machine. Sellew Machine Tool Co., Pawtucket, R. I. 418
Blount Motor-driven Buffing Machines. J. G. Blount Co., Everett, Mass. 418
Newton Straddle-milling Machine. Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. 418
Cincinnati-Acme Turret Lathe Staybolt Attachment. Acme Machine Tool Co., Cincinnati, Ohio 419
Pratt & Whitney Die-sinking Machine. Pratt & Whitney Co., Hartford, Conn. 419

How To Reduce Production Costs ?

Gardner Automatic Double-spindle Grinding Machine. Gardner Machine Co., 414 Gardner St., Beloit, Wis. 420
Black & Decker Portable Drill. Black & Decker Mfg. Co., Towson Heights, Baltimore, Md. 421
LeBlond Cutter and Hob Grinder Attachment. R. K. LeBlond Machine Tool Co., Cincinnati, Ohio 421
Murchey Nipple Reaming and Chamfering Machine. Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich. 421
"Parabolic" Milling Cutters. National Twist Drill & Tool Co., Detroit, Mich. 422
Lucas Vertical Broaching Press. Lucas Machine Tool Co., Cleveland, Ohio 422
Southwark Hydraulic Automobile-body Press. Southwark Foundry & Machine Co., Philadelphia, Pa. 423
Oliver Improved Self-feed Rip Saw. Oliver Machinery Co., Grand Rapids, Mich. 423
"Pakfull" Sectional Filing Equipment. Economy Drawing Table & Mfg. Co., Adrian, Mich. 423
Elgin Bench Lathe Unit. Elgin Tool Works, Inc., Elgin, Ill. 424
Harrington Multiple-spindle Drilling Machine. Edwin Harrington Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa. 424
Eclipse Interchangeable Spot-facer and Counterbore. Eclipse Interchangeable Counterbore Co., 7410 St. Aubin Ave., Detroit, Mich. 425
Conradson Upright Drilling Machine. Prentice Conradson, Green Bay, Wis. 425
Sundstrand Tool-room Lathe. Rockford Tool Co., 2400 Eleventh St., Rockford, Ill. 426
Pedrick Boring Unit. Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia, Pa. 426
American Improved Air-operated Chucks. S-P Mfg. Co., 872 E. 72nd St., Cleveland, Ohio 427
Jacobs Drill Chuck. Jacobs Mfg. Co., Hartford, Conn. 427

Fellows High-speed Gear Shaper

A NEW high-speed gear shaper designed to meet the requirements of manufacturers having a large number of gears of one particular size to cut, but which is so arranged that by the provision of suitable work-holding fixtures it can be adapted for many classes of work, is being introduced to the trade by the Fellows Gear Shaper Co., Springfield, Vt. This new machine is in many respects similar to the standard gear shaper built by this concern. External, internal, and helical gears can be handled. A special feature of the machine is that it can automatically take roughing and finishing cuts in one setting and with the same cutter. This is obviously an important factor in a production machine, as it eliminates the performance of second operations.

Principle of Operation

The principle of operation is fundamentally the same as that of the standard gear shaper in that the cutters used resemble gears and are employed on the generating principle. These cutters are standard and have the teeth generated with precision after hardening. Because of the high speed at which the cutter is operated and the short stroke of the machine it is not the practice to machine several gears at one time, except when they are very thin; but even though only one gear is machined at a time, high rates of production are secured. An advantage obtained by this method is that inaccuracies produced when a number of gears are held on one arbor are eliminated.

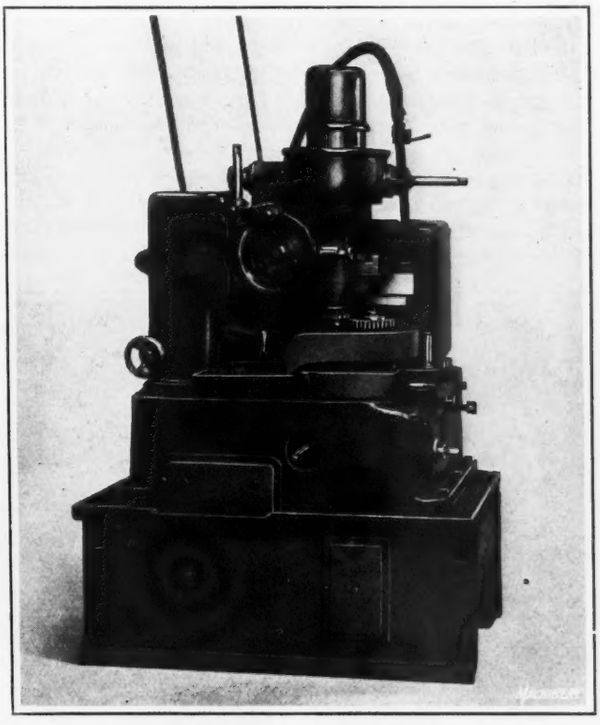


Fig. 1. High-speed Gear Shaper made by Fellows Gear Shaper Co.

As the cutter has a comparatively short stroke, and can therefore be operated at a high rate of speed, it remains in contact with the work for only a short period of time. This contact is so short that the cutter does not become heated and so its keen cutting edge is not impaired. As the work also does not become heated, variations in the teeth due to changes in temperature are not met with. Cutting compound is pumped to the cutter and the work to keep them cool, and this enables the machining of alloy steel gears to be done rapidly and accurately.

As on the standard gear shaper, change-gears are provided for taking care of the

difference between the number of teeth on the cutter and the number of teeth on the gear being cut, but owing to a modification in the design of this machine the ratio is different, as will be explained later. The method of obtaining the rotary feed for the cutter also differs, and this too will be dealt with subsequently.

The Cutter-spindle and Saddle

The cutter-spindle is guided in a straight path by accurately finished guides, being reciprocated by means of a connecting-rod and crank-arm which may be clearly seen in Fig. 3. The operating end of the crank-arm has a hardened steel gear segment on it which meshes with rack teeth on the cutter-slide. The crank-arm has a bronze bushing at the fulcrum, and is equipped with ball bearings where it is attached to the connecting-rod. The connecting-rod is operated through a crankshaft having an adjustable crankpin, the position of which governs the length of the cutter stroke. The lower end of the connecting-rod is mounted on a self-aligning ball bearing on the crankpin, this construction permitting the use of high reciprocatory speeds.

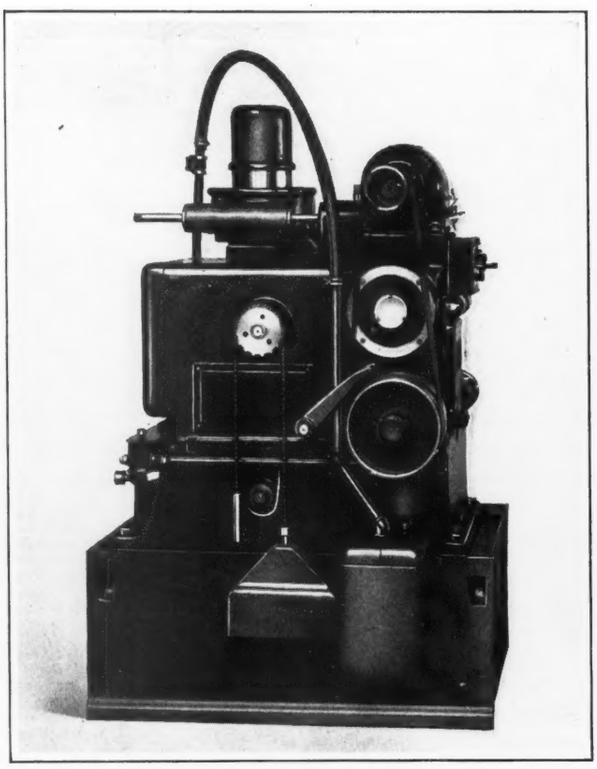


Fig. 2. Rear View of the Fellows High-speed Gear Shaper equipped with Individual Motor Drive

The crankshaft is made from an alloy steel forging, and is driven from the rear through a single-pulley drive. This construction enables a group of gear shapers to be driven from a jack-shaft, without the employment of a countershaft. As shown in the rear view of the machine, Fig. 2, provision has also been made for the installation of an individual motor drive, a bracket being fastened to the top of the machine for attaching the motor. A 1-horsepower motor provides sufficient power for operating a single machine. When a group of machines is installed, it is economical to bolt the machine bases together and operate the machine as one unit. When this is done a 6-horsepower motor furnishes ample power for ten machines.

The position of the saddle carrying the cutter-slide is adjusted to suit different gear diameters by means of a worm, worm-wheel, pinion, and rack, and can be withdrawn to permit the location and removal of work. The saddle is mounted on accurately machined guides on the face of the housing. For the depth feed it is advanced toward the work by means of a cam which may be seen in Fig. 3, provision being made on this cam for automatically taking both roughing and finishing cuts. The cutter is gradually fed to the proper depth as the blank and cutter are rotated together. The cutter overlaps on the finishing cut so as to prevent variations in the thickness of the teeth.

Work-spindle and Relieving Mechanism

The work-spindle is almost identical in design with that on the standard gear shaper in that it carries a reverse taper work-arbor. It is rotated by means of worm-gearing which is directly connected through gears and shafts to the upper worm and index-wheel which operate the cutter. The spindle is held in an apron located in an accurately machined seat in the bed. The work is withdrawn from the cutter on the return stroke by means of a relieving mechanism consisting of a cam at the rear of the machine which operates the apron lever through a connecting-rod. This mechanism may be seen in Fig. 5.

Speed and Feed Mechanisms

As previously stated, the proper relation between the number of teeth on the cutter and on the work is secured through change-gears which the operator is in the act of changing in Fig. 5. Owing to the fact that the upper and lower worm-wheels have the same number of teeth, the ratio between the cutter- and the work-spindles is 1 to 1, and so the computation necessary in selecting the proper change-gears for a job is easy. Any needed pair may be determined by the use of a simple formula, which is cast on a plate fastened to the machine just above the change-gears. After a set of gears has been placed on the shafts, the gears are protected by a cover. The time for a gear-cutting operation is controlled by the speed at which the cutter-spindle is operated, in conjunction with the rotary feed. Change-gears are also provided for this feed, which are accessible by removing a plate; this was done prior to taking the photograph

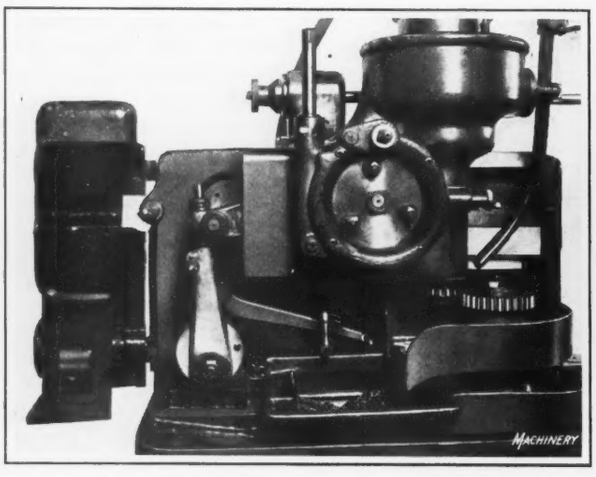


Fig. 3. Close-up View of Mechanism which imparts Reciprocating Movements to the Cutter-spindle

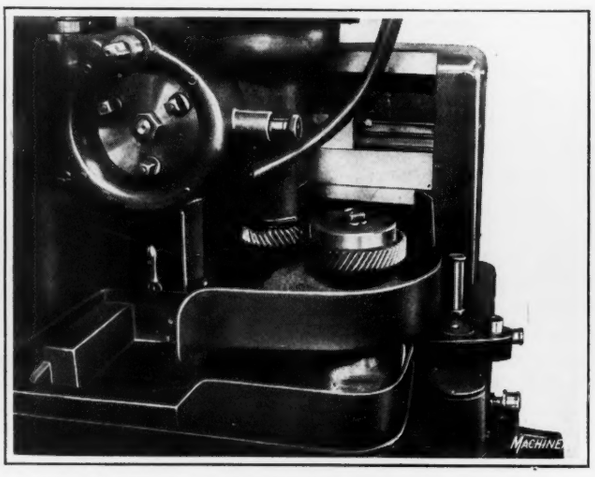


Fig. 4. Cutting an Automobile Engine Helical Timer Gear on the Gear Shaper

reproduced in Fig. 6. The plate is held in place by means of four safety set-screws. The rotary feed is expressed in strokes of the cutter per revolution, and gears are provided for securing seven different feeds ranging from coarse to fine. A feed chart is attached to the plate covering the feed gears. The coarsest feed is 435 strokes per complete revolution of the cutter, while the finest feed is 1735 strokes per complete cutter revolution. The selection of a feed is governed by the material being cut, a coarser feed, of course, being used for cast iron than would be possible for alloy steel. Roughing and finishing cuts are taken at the same rates of feed and speed.

Oiling Provisions

The machine has been designed to run with little attention so far as oiling is concerned. All high-speed shafts are mounted in ball bearings and are automatically lubricated. A reservoir in the bed holds two and one-half quarts of light machine oil, which is pumped to additional reservoirs from which wicks carry it to the different bearings. The cutter-spindle shoe and guide are lubricated from a reservoir in the saddle housing which may be exposed by removing a cover. A reservoir provided on the apron may be filled after unscrewing a cap. Only three grease cups are furnished on the machine, these being supplied because it was found that for a slight oscillatory movement, grease is more satisfactory than oil. Only one turn of the cups per day is sufficient to keep the working members well lubricated.

As previously mentioned, a 1-horsepower motor furnishes ample power to cut any type of gear within the capacity of the machine; this is due to the fact that all reciprocating members are light in weight and all high-speed shafts are mounted on ball bearings.

Provisions for Cutting Internal, Helical and Herringbone Gears

This gear shaper will handle any form of gearing used in standard automobile construction, as well as some gears of special design. It may be used for cutting both steps on a countershaft gear and the external and internal teeth on an internal clutch gear. In adapting the shaper for cutting internal gears, a slight modification is necessary in the design of the machine, owing to the fact that in cutting an internal gear the cutter must work on the right-hand side relative to the center of the work-spindle, instead of on the left-hand side. A special crank-arm is necessary with this arrangement, but all other members of the machine are identical in design with those on a machine for cutting external gears only.

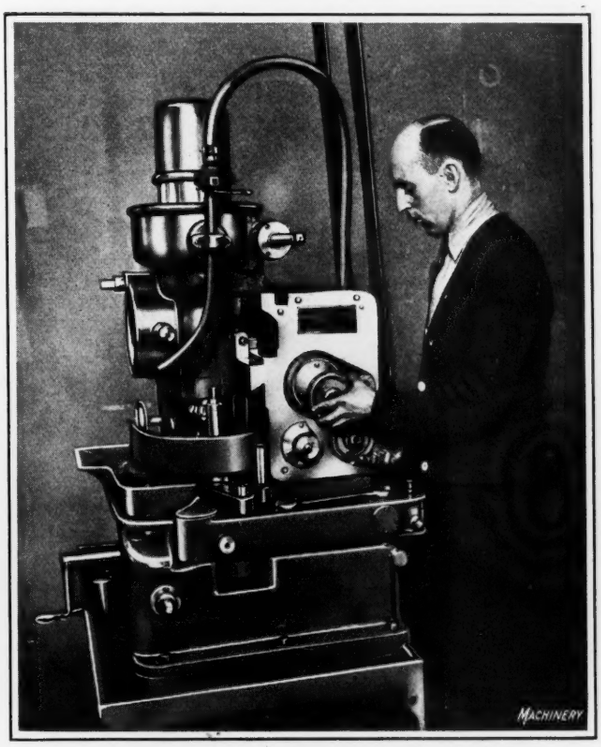


Fig. 5. View of Right-hand End of Machine showing Speed-change Gears and Relieving Arm connected to Work Apron Lever

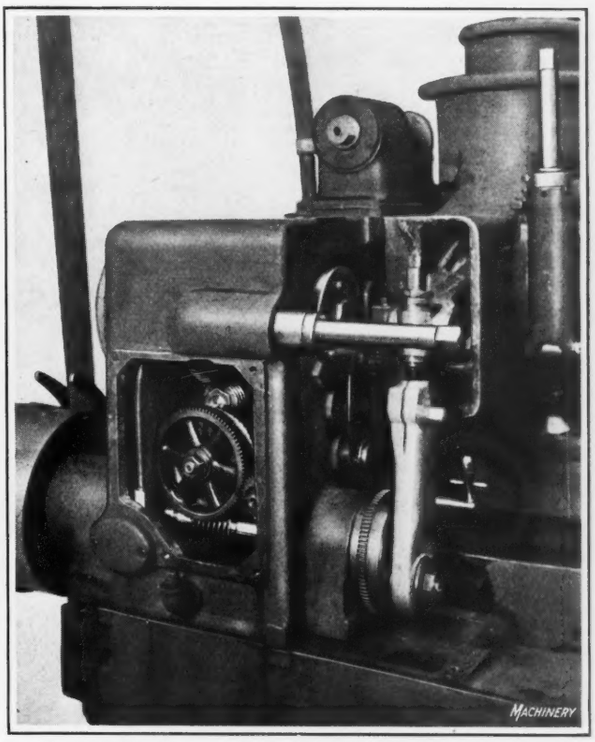


Fig. 6. View taken from the Left-hand End of Machine, showing Feed-change Gears, Crankshaft, Connecting-rod, etc.

By another slight modification somewhat similar to that used on the standard gear shaper for the same purpose, this high-speed shaper can be adapted for cutting helical and herringbone gears. Fig. 4 illustrates an operation on a timer gear for an automobile engine.

BARBER-COLMAN AUTOMATIC HOB-SHARPENING MACHINE

The proper sharpening of any cutting tool is essential if maximum efficiency is to be obtained in the operation of the tool, but in the case of formed cutters and hobs, it is a matter of exceptional importance, because tools of these types have their teeth relieved to allow for sharpening and still retain the form of each tooth throughout its entire length. To enable a cutter or hob to produce its true form continuously, it must be so sharpened that the cutting face of each tooth is on a radial line with the center of the cutter. In order to eliminate the personal element in the performance of such cutter grinding operations, the Barber-Colman Co., Rockford, Ill., has developed the automatic hob-sharpening machine here illustrated. Although primarily designed for sharpening hobs up to 4 inches in diameter and 4 inches in length, it is equally applicable to sharpening formed cutters of sizes within the capacity of the machine.

The hob to be sharpened is mounted on a mandrel carried in the headstock spindle and having the outer end supported by a sliding tail-center. A reciprocating motion is imparted to the work-slide, so that the hob moves back and forth under the grinding wheel. After each forward and return stroke of the table, the hob is indexed by a mechanism which provides for indexing hobs with different numbers of gashes. It is an easy matter to change the machine to grind a different hob. The machine is readily set for grind-

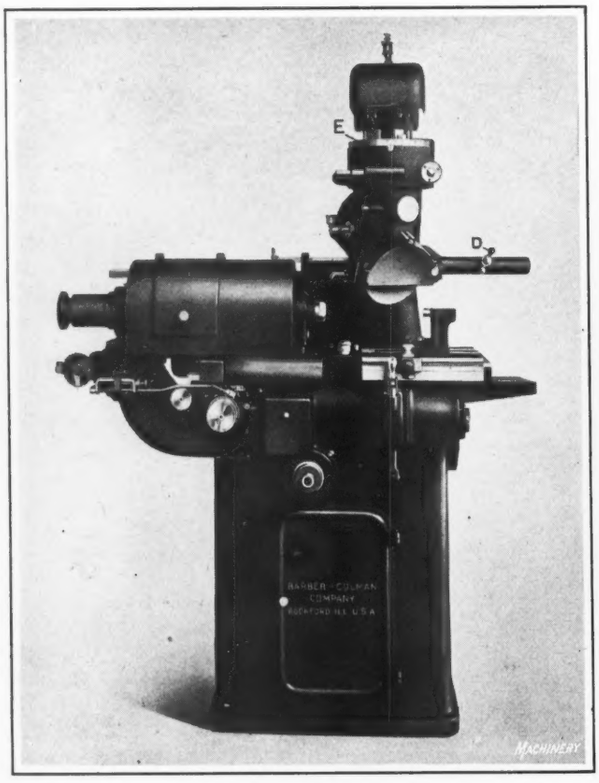


Fig. 1. Automatic Hob-sharpening Machine brought out by the Barber-Colman Co.

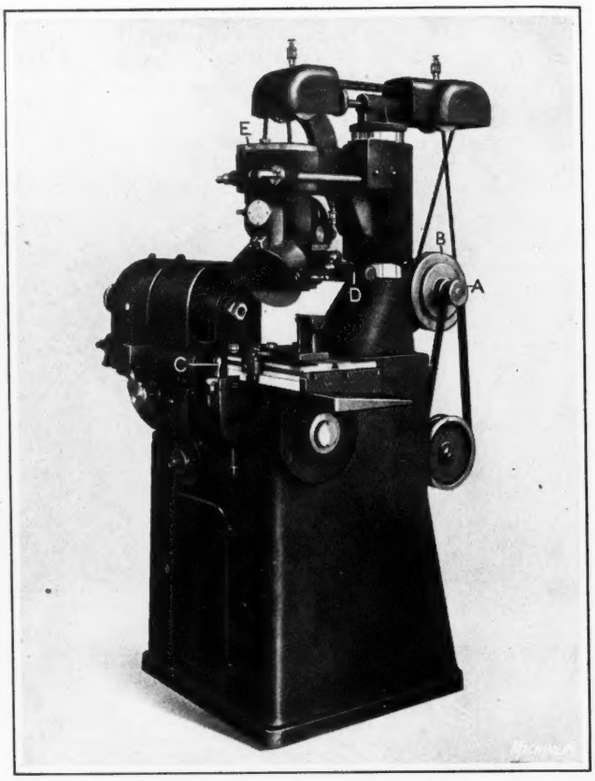


Fig. 2. Driving End of Barber-Colman Belt-driven Hob-sharpening Machine

ing hobs with either straight or spiral gashes, of various degrees of angularity, and either right- or left-hand. Provision is also made for feeding the hob to the grinding wheel after each complete revolution of the work, regardless of the number of gashes. The faces of the hob teeth are always ground or sharpened to conform with true radial lines from the hob center, irrespective of whether the gashes are of straight or spiral form.

The machine is driven from a countershaft *A*, Fig. 2, which carries tight and loose pulleys, but when motor drive is desired, the countershaft is dispensed with and pulley *B* is mounted directly on the motor shaft, the motor being set on a base substituted for the countershaft bracket. Power for driving the grinding wheel spindle is furnished by means of an endless belt running over grooved idler pulleys mounted on ball bearings, and is transmitted to the grinding wheel spindle by spiral bevel gears at the back of the wheel-head. The wheel-spindle is also equipped with Norma ball bearings which are mounted in a sleeve so that the entire construction is self-contained.

At the rear end, the wheel-spindle is extended through and loosely splined within the hub of the driven gear, affording the equivalent of a floating drive for the wheel-spindle which does away with any tendency toward vibration or loss of accurate alignment. Reciprocation of the work-table is accomplished through a drum cam driven from the rear of the machine. The friction clutch may be disengaged at any time by lever *C*, to stop the work in any desired position relative to the wheel. A diamond wheel-truing device *D* provides for keeping the grinding wheel accurately dressed.

In grinding hobs with spiral gashes, it is necessary to impart a reciprocating rotary movement to the work as the hob moves back and forth under the grinding wheel; no such movement is, of course, necessary in the case of straight-gashed hobs. The grinding wheel must also be set to suitable angles for grinding hobs with various forms of gashes. The wheel-head has a graduated dial *E* by means of which the wheel may be set to any desired angle with the line of travel of the work-table.

The reciprocating rotary movement of the work is accomplished by means of a slide *F*, Fig. 3, the top of which

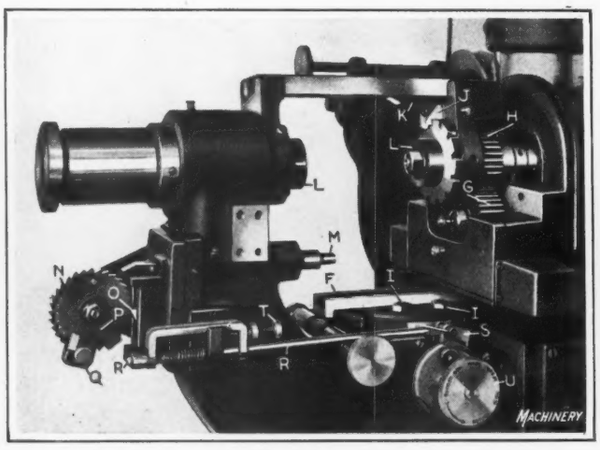


Fig. 3. Mechanism for imparting Reciprocatory Rotary Movement to Spiral-gashed Hobs, for indexing and for feeding

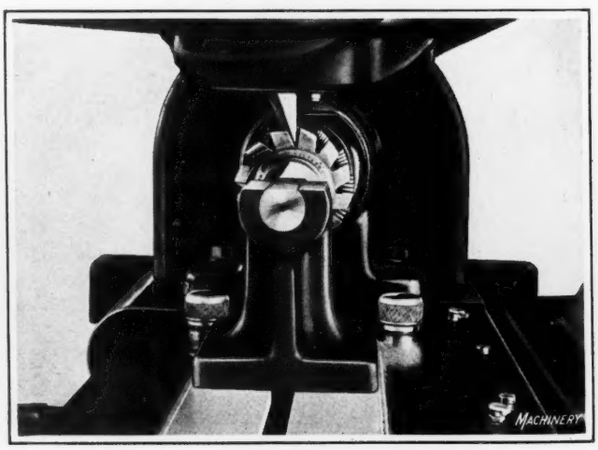


Fig. 4. Close-up View of Tailstock showing Setting of Grinding Wheel for sharpening Spiral-gashed Hobs

is grooved to receive a sliding block secured to the under side of a transverse rack. This rack meshes with idler pinion *G* which, in turn, transmits movement to pinion *H* secured to the work-spindle. Slide *F* may be set to various angles, either right- or left-hand, or located parallel to the line of travel of the table, according to the form of the gashes in the hob. The support on which slide *F* is mounted is furnished with a graduated dial, similar to dial *E*, so that angular settings may be accurately made without loss of time. After the setting has been accomplished, the slide is locked by means of two nuts *I*.

The mechanism employed for indexing the hob to suit the number of gashes is also clearly shown in Fig. 3. While a forward and return stroke of the work under the grinding wheel is in progress, the work is held in a definite position relative to the wheel by means of a dog *J* that enters a notch in the index-plate. As the slide approaches the end of its return stroke, cam *K* draws this dog out of the notch in the index-plate, and at the same time the two ratchet members *L* come into engagement. The left one of these members has a coarse-pitch screw running in a nut in the supporting bracket. Continuation of the table movement pushes the left-hand ratchet member *L* toward the left, the screw causing it to rotate and thus turn the index-plate. Immediately after the rotation commences, the catch carried by cam *K* releases dog *J*, so that it slides over the face of the index-plate and is free to snap into the next notch, thus locating the work for grinding the next consecutive gash.

While movement of the table toward the left indexes the work, it also provides for feeding the work toward the grinding wheel. This is accomplished by the engagement of the left-hand end of the table with plunger *M* that actuates a pawl and ratchet *N*. At each forward and return stroke of the table, this ratchet is turned and locked in place by means of a catch *O*. When the work has made one complete revolution, dog *P* disengages catch *O* to allow ratchet *N* to return to its starting position, and at the same time dog *Q* strikes the end of the feed mechanism plunger *R* and, through the action of a ratchet and pawl *S*, turns a feed-screw that imparts a transverse movement to the cross-slide on which slide *F* is mounted. This movement of the slide, through the medium of the rack and gears *G* and *H*, rotates the hob in such a way that it moves toward the grinding wheel and provides for taking a deeper cut. This indexing takes place after each complete rotation of the work. A graduated slide can be set by thumb-screw *T* for taking a cut from 0.0005 to 0.002 inch deep, according to requirements. Hand feeding may be accomplished by turning wheel *U*.

When furnished with an individual motor drive a two-horsepower motor running at 1800 revolutions per minute is furnished. The machine will handle spiral hobs with gashes of any angle from 30 degrees left-hand to 30 degrees right-hand. The grinding wheel is 7 inches in diameter. Seven index-plates are furnished for hobs having from ten to sixteen gashes. The machine weighs about 2250 pounds.

GLEASON 4-INCH SPIRAL BEVEL GEAR GENERATOR

The increasing demand for spiral bevel gears in preference to the straight-tooth type for certain purposes has led to the development of interesting and ingenious designs of machines at the Gleason Works, Rochester, N. Y. A 4-inch spiral bevel gear generator especially adapted for cutting small gears for sewing machines, motion picture machines, etc., is illustrated in Figs. 1 and 2. This machine finishes the tooth space from solid stock in one operation instead of cutting one side of a tooth at a time, as is frequently done when using machines designed for larger work. One of the distinguishing features of this 4-inch generator is that all the generating motion is applied to the gear, instead of rolling the gear and cutting tools together, as is done on the larger spiral bevel gear generators, and also on the machines used for generating straight-toothed bevel gears.

Fig. 1. Gleason 4-inch Spiral Bevel Gear Generator

The work-spindle is carried by a segment-shaped base and has the indexing mechanism at its outer end. The work-spindle is adjusted, according to the angle of the gear or pinion to be cut, upon this segment-shaped base which is attached to a drum or cradle that is given a rolling motion. This rolling cradle is oscillated by a crank mechanism through a connecting link. The crank mechanism consists of an ordinary slotted crank, for varying the amount of rolling motion, and is driven by worm-gearing and a Whitworth motion which accelerates the movement of the cradle after a tooth space is finished and the motion has been reversed.

The rolling movement of the cradle causes the work-spindle axis to swing about axis *A*, Fig. 2, which is the axis of both the cradle and the crown gear segment *B*. Segment *B* is fixed and is engaged by a master gear segment *C* having an arm or extension connecting with the work-spindle sleeve. The latter is locked to the work-spindle, except when the indexing pawl is released; consequently, as the work-spindle swings bodily about the axis *A*, gear segment *C* rolls upon the stationary crown gear segment *B*. The result is that the movement of the work-spindle axis corresponds to the path described by the axis of an imaginary gear rolling upon a crown gear; moreover, the rotation of the work-spindle about its own axis, as derived from segment gears *B* and *C*, corresponds to the rotation of the imaginary gear about its axis. The motion of the gear blank relative to the cutter is the same as on machines which are designed to apply the generating motions to both gear blank and cutting tools. The latter machines, however, are so arranged that the work-spindle and gear blank rotate about a *fixed* axis, while tools representing the sides of crown gear teeth are also given a rolling motion corresponding to the rotation of a crown gear about its axis.

The action of the machine when cutting a gear is as follows: The cutter, which is given an in-and-out movement, begins to cut as the work-spindle approaches the bottom of the rolling movement. As the gear rolls upward, one tooth space is finished on both sides, and when near the upper end

of the rolling movement the cutter begins to withdraw. Then as the downward or backward motion begins, the work indexes, the cutter gradually advancing into the work during the remainder of the downward movement. The indexing movement is derived entirely from the generating motion through an ingenious mechanism located at the outer end of the work-spindle.

This machine is driven by two ½-horsepower motors. One motor drives the cutter-spindle through a flexible coupling and a pinion meshing with a large gear located just back of the cutter-head. The other motor supplies power for the feeding movement of the cutter-spindle head, and also for the generating action. The feeding movement of the cutter-head is obtained from a cam designed to give a relatively slow movement while the cutter is at work and a rapid return. The in-and-out movement can be varied according to the depth of the tooth by means of an adjustable cam-lever, which is similar in principle to the design used on other types of Gleason machines.

The cutter-spindle slide with its driving motor may be adjusted vertically, and a horizontal adjustment is also provided for the cutter-head. These adjustments permit setting the cutter in the correct position relative to the gear blank, according to both the spiral angle and the "hand" of the spiral. A reversible motor is used for the cutter-spindle, so that the rotation can be changed for using either a right- or a left-hand cutter. Graduated dials on the horizontal and vertical adjusting screws for the cutter-slide enable the latter to be set accurately to any given position by referring to a chart worked out for different gears.

The cutters are made either right- or left-hand and range in diameters from 1.10 to 3.5 inches. The small cutters are made solid and have four blades, two cutting on the inside and two on the outside. The larger cutters have eight adjustable blades, four cutting inside and four outside. The same cutter may be used for both gears and pinions, but the vertical position relative to the center of the work must be changed. Thus if the center of the cutter is below the center of the gear, it must be set above the center when cutting the mating pinion, since the latter must have left-hand teeth if the gear has right-hand teeth, or vice versa. The time required for cutting gears on this machine varies widely for different classes of work, the range being from five to twenty-six seconds per tooth.

The capacity of this machine is shown by the following specifications covering the 3½-inch cutter. Longest cone distance, 30-degree spiral angle, 2⅛ inches; longest face, ½ inch; greatest pitch angle, shafts at 90 degrees, 75 degrees 58 minutes; smallest pitch angle, shafts at 90 degrees, 14 degrees 2 minutes; extreme ratio, shafts at 90 degrees, 4 to 1; largest pitch diameter, 4 to 1 ratio gear, 4 inches; largest pitch diameter, 4 to 1 ratio pinion, 1 inch; largest pitch diameter, 4 to 1 ratio, 3 inches; largest diametral pitch, 10.

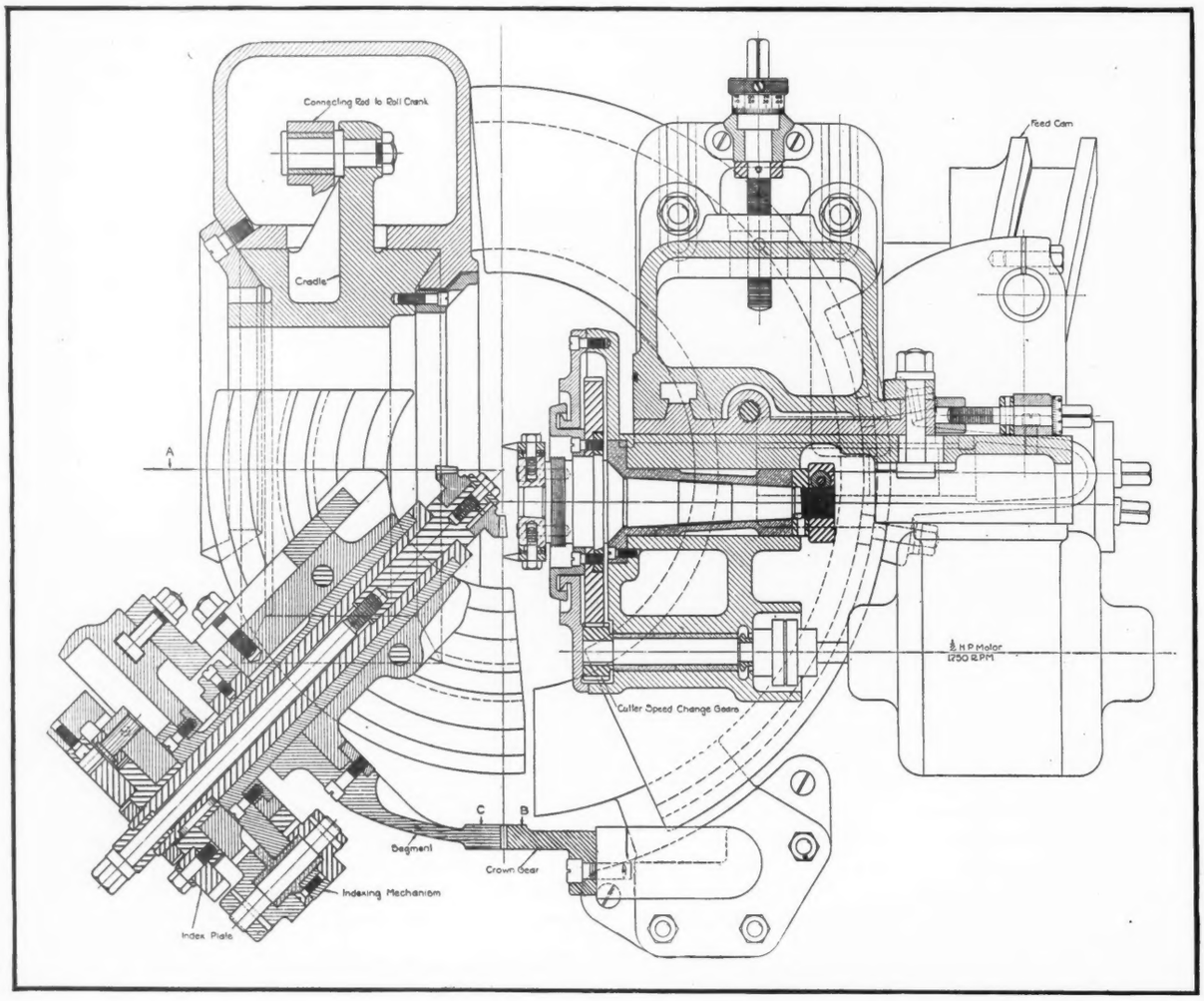


Fig. 2. Sectional Plan View of Generator for cutting Small Spiral Bevel Gears

The equipment regularly furnished includes a set of eight cutter speed-change gears; a set of twelve feed-change gears; a set of eleven segments; an index-plate; a cutter gage; an automatic stop; and a gear-driven cutting-oil pump. The machine weighs approximately 2000 pounds, and occupies a floor space of 33 by 44 inches. A description of the Gleason 8-inch generator for spiral bevel gears was published in April, 1921, MACHINERY, and an article on the first machine of this type built by the Gleason Works appeared in April, 1914, MACHINERY.

UNIVERSAL "TRI-WAY" HORIZONTAL BORING MACHINE

A newly designed horizontal boring machine intended for handling heavy work in railroad and other shops, which is known as the "Original Tri-way" from the fact that the bed has three flat ways, has been placed on the market by the Universal Boring Machine Co., Hudson, Mass. The front one of the three ways and the center way serve as guiding surfaces for the sliding members on the bed, while the rear way helps to support the long carriage. The construction will be apparent by reference to Fig. 1. The bed is also designed for a coolant system, the top sloping toward the head end so that the coolant runs into a settling chamber at the end of the bed. From this settling chamber it overflows into another chamber from which it is pumped through piping to the work.

The design of the carriage and table is similar to that of the No. 3-A and 3½ machines built by this concern, except that the members are heavier and are designed to take care of coolant without piping. The head post has been provided with wide bearing surfaces for the head. The head has a reversing lever for the boring-bar, slow hand-feed for the boring-bar, and a lever for throwing in the higher boring-bar speeds. The handwheel on the head is used to obtain the fine hand-feeds, and the sprocket wheel for rapid hand-feeds. The vertical lever between the two is for reversing.

The starting and stopping lever of the machine is at the front of the bed and operates a friction clutch that controls the rotation of the main driving shaft. The gears for obtaining the various speeds and feeds are arranged in geometrical progression, and are operated by levers at the right-hand end of the bed. Attention is called to the convenient location of all control levers at this end of the machine. The left-hand upright lever is employed for throwing in either the table cross-feed, the longitudinal carriage feed, or the vertical head feed. The central upright lever is used to throw in all feeds and to effect rapid traverses, while the right-hand upright lever is used to reverse the feeding of the various members.

Wear of the rear post elevating screw may be compensated for by means of the nuts at the upper end of the screw. From the end view of the machine shown in Fig. 2, the method of mounting the driving motor may be readily observed. A few of the principal dimensions of the machine are as follows: Automatic travel of main boring-bar, 30 inches; travel of main boring-bar by resetting, 60 inches; size of table, 30 by 63 inches; power cross-feed of table, 48 inches; power longitudinal feed of carriage, 40 inches; power vertical feed of head, 30 inches; maximum distance from table to center of boring-bar, 30 inches; and greatest distance from faceplate to outer support, 72 inches.

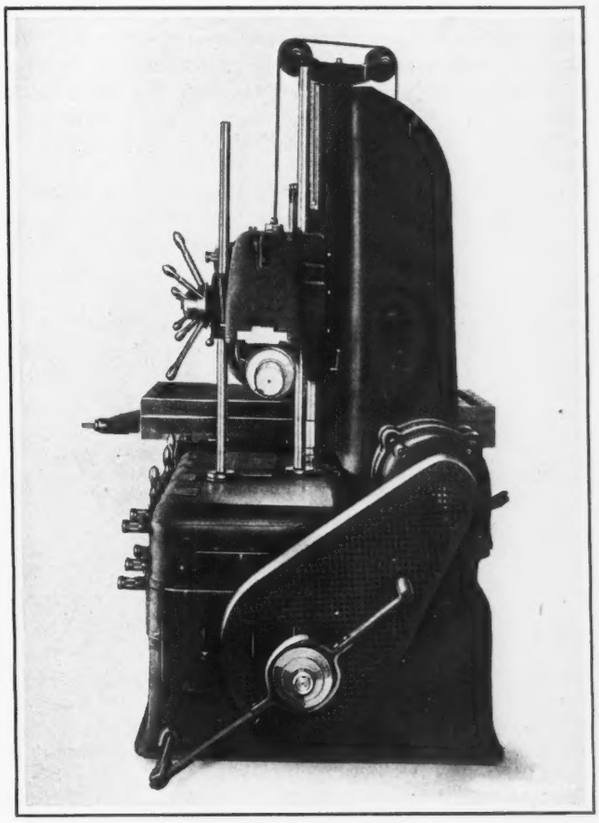


Fig. 2. End View of Boring Machine, illustrating the Motor Driving Arrangement

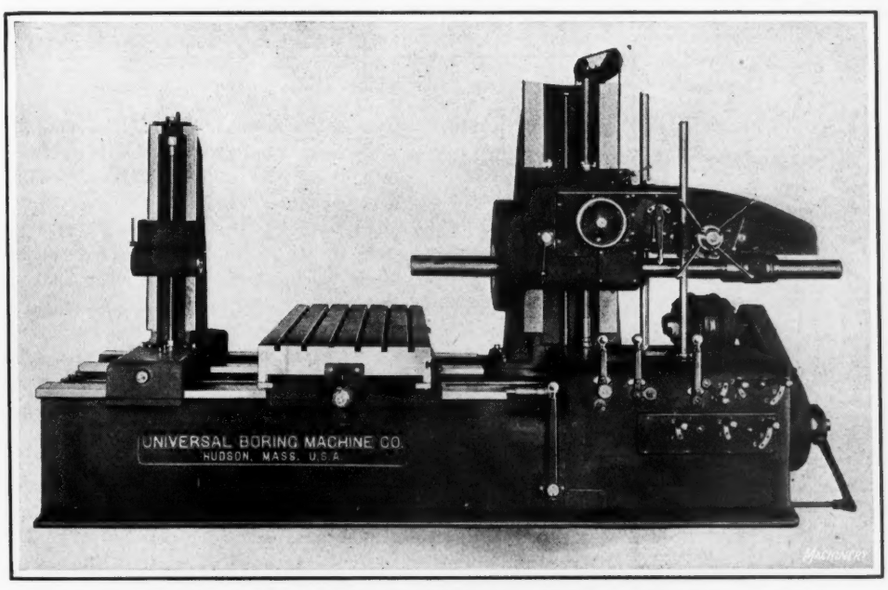


Fig. 1. "Tri-way" Horizontal Boring Machine developed by the Universal Boring Machine Co.

BRYANT WRIST-PIN HOLE GRINDING MACHINE

A double-head internal grinding machine primarily designed for finishing the wrist-pin holes of automotive engine pistons, but which can also be adapted for grinding holes in opposite ends of long pieces that cannot be handled conveniently on a single-wheel machine, has been placed on the market by the Bryant Chucking Grinder Co., Springfield, Vt. The main features of design of this machine are the same as on other machines built by this company. From the front view, shown in Fig. 1, it will be noted that the two grinding wheel heads are carried on the same slide. In the positions shown, the wheels are withdrawn from the hole preparatory to swinging the wheel-heads to the rear to permit gaging or changing of the work.

The work-holding fixture is mounted on the bed at about the middle, and from the sectional view of this fixture shown in Fig. 2, it will be seen that the piston is located in a vee and held securely in place by a clamp that operates against the inner surface of the piston directly over its contact points with the vee surfaces. The clamp is operated by a half turn of the wing-screw *A*. Body *B* of the

fixture is provided with a stationary race *C* for the balls placed between this member and the rotating ring. The latter is held in place by the ball thrust bearing *D* which is secured to the chuck by ring *E*. The rotating members of the chuck are driven from the countershaft by belt *F*.

Fig. 3 shows the open side of the chuck after a piston has been removed. The clamp is in position for gripping the work at points *G*. In locating a piston, its skirt is slipped under the clamp, and the hand centering plug *H*, which fits a hole in the closed face of the fixture, is put in place and

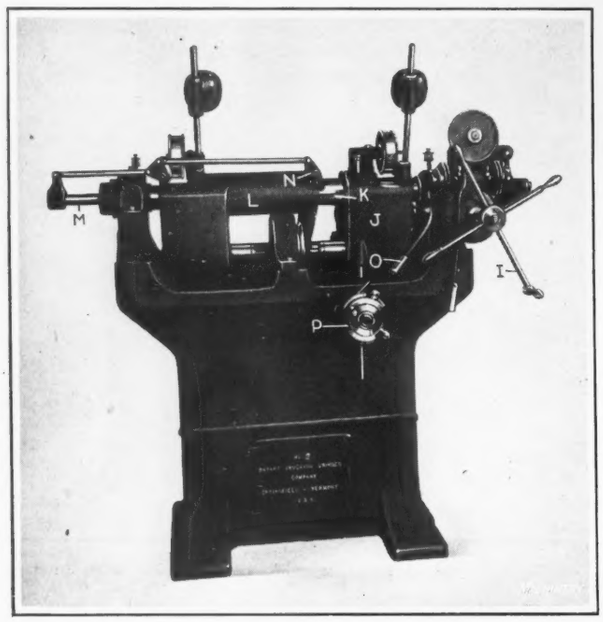


Fig. 1. Double-head Internal Grinding Machine developed by the Bryant Chucking Grinder Co.

passed through the wrist-pin holes. This plug, of course, is of a size to fit the wrist-pin holes before they are ground. With the piston in place ready for grinding, the wheel-heads are swung down into the positions shown in Fig. 1, by turning handwheel *I*. Slide *J* is attached rigidly to the slide bar *K*, while slide *L* can be moved longitudinally on the bar. The movable slide is prevented from rotating on the slide

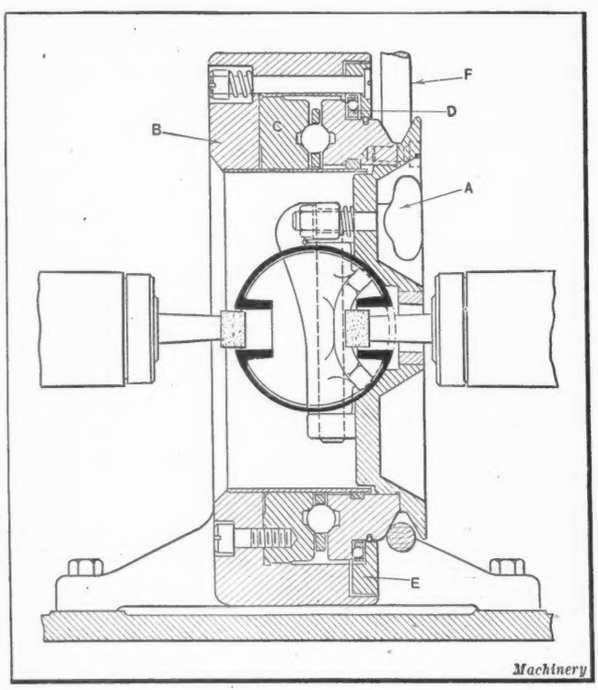


Fig. 2. Sectional View of Fixture for holding Automotive Pistons in Position for Operation

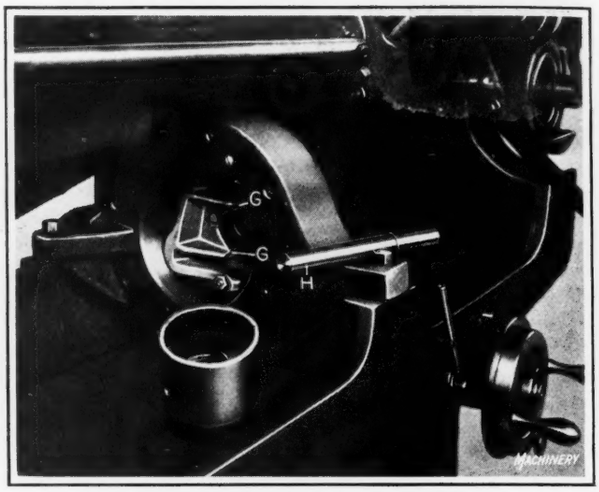


Fig. 3. Close-up View of Work-holding Fixture

bar by means of a bar located at the rear of the machine, which allows longitudinal movement between the two wheel-heads but keeps the wheels in correct alignment.

The relative movement of the slides is obtained by means of racks which operate through bar *M*. As the wheels are advanced toward each other, crank-arm *N* strikes a stop and causes the movable slide to be clamped to the bar in the proper position. As previously stated, these actions of the machine are all obtained by one movement of handwheel *I*. Dropping lever *O* disengages one rack, and the two wheel-heads may then be operated as a single unit. The wheel

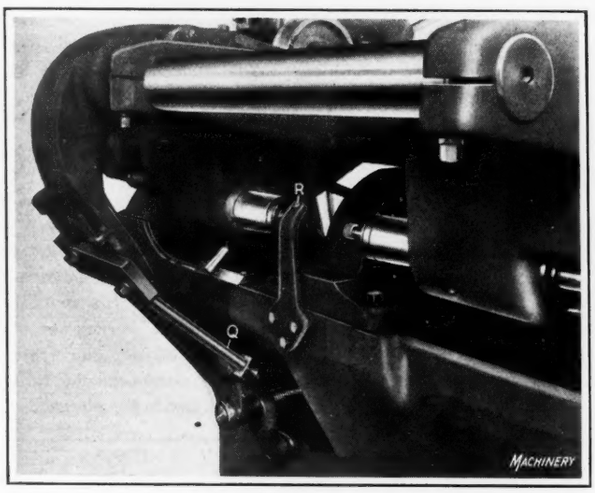


Fig. 4. Method of dressing the Grinding Wheels

traverse when grinding is provided for by a "load and fire mechanism" having reversing stops that are adjustable to give the desired length of stroke. This reversing mechanism is driven by a belt from the countershaft.

The cross-feed is obtained by means of handwheel *P* at the front of the machine, which operates against a control plate clamped to an arm on the wheel-slide at the back of the machine, as shown in Fig. 4. The cross-feed extension *Q* is swung into position between the end of the feed-screw and the control plate, and adjusted so as to bring the wheels in contact with diamond *R*. The wheels must necessarily be separated in order to clear the fixture when they are being swung into the truing position. However, they are brought together again before dressing, to the same relative positions they occupy when grinding work. This insures that the two wheels will be dressed with the grinding points in line. The machine has a capacity for pistons up to 4½ inches in diameter and 4½ inches in length. The work-spindle operates at a speed of 250 revolutions per minute. The entire equipment weighs about 2300 pounds.

GORDON CRANKSHAFT-CHEEK TURNING LATHE

All the cheeks of automobile engine crankshafts are turned simultaneously on the machine shown in the accompanying illustrations which was developed by the Gordon Form Lathe Co. and is being built by the Willard Machine Tool Co., A St., Box 784, Cincinnati, Ohio. The particular machine illustrated is equipped with eight rocker arms, each of which controls a tool held in a block that swivels in the rocker arm, the number of rocker arms corresponding to the number of cheeks on the crankshaft. The rocker arms are located back of the work and swing from an over-arm shaft to and from the crankshaft to suit the contour of the cranks. The rocker arms are spaced to coincide with the spacing of the various crankshaft cheeks, by means of collars on the over-arm and guide plates fixed to the main frame of the machine. The guide plates are inserted in the rocker arms below the tool-blocks.

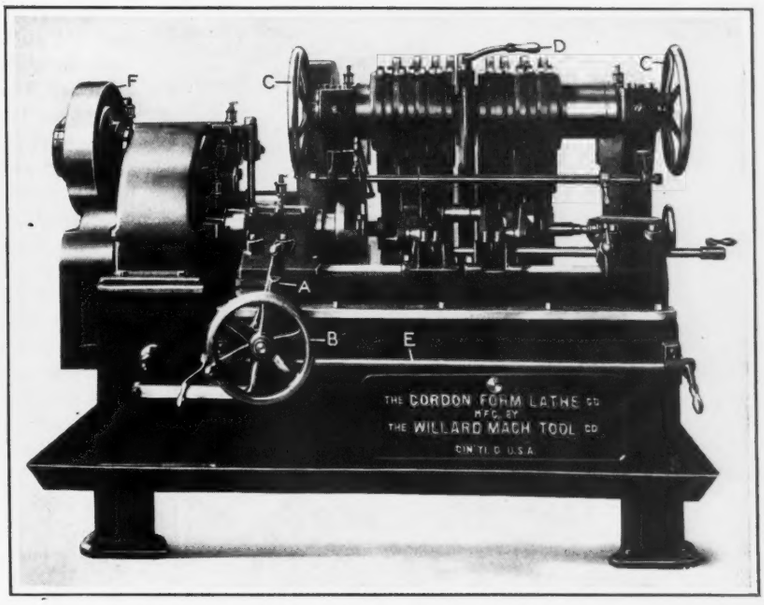


Fig. 1. Crankshaft-cheek Turning Lathe developed by the Gordon Form Lathe Co. and built by the Willard Machine Tool Co.

Feeding of the work is accomplished by movement of the platen, which is fed by a screw. A gear quadrant connected to the feed-screw at the front end of the machine provides a large range of fine and coarse feeds. An automatic trip serves to throw out the feeding movement through lever *A* at the conclusion of the cuts across the crankshaft cheeks. At the completion of an operation, the platen is returned to its starting position by turning handwheel *B*. The headstock, tailstock, and steadyrests are bolted to the platen to make one unit and travel as a unit with the work.

The machine has been arranged for taking both roughing and finishing cuts, this being controlled by two eccentric bushings which are located in the outer bearings of the over-arm and may be adjusted to a fixed stop by the large handwheels *C*. After the over-arm has been adjusted to either the roughing or finishing position, it is locked in place by lever *D*. The locking of the over-arm is at its central support which is a housing bolted to the main frame of the machine. The starting and stopping of the machine is accomplished quickly by means of shaft *E*, which has an operating lever at each end. Ample chip clearance has been provided between the bottoms of the rocker arms and the platen. The chips fall directly into a chip pan within the machine, and can be removed through the large door on the front of the bed. Cutting lubricant is supplied to the tools through a pipe extending past the rocker arms and having a tube leading to each tool. The lubricant pump is driven by belt as will be seen by reference to Fig. 2.

The main drive of the machine is through the friction-clutch pulley *F* which is geared directly to the main intermediate shaft *G*. It will, of course, be evident that there is a varying distance between the center line about which the crankshaft revolves and the point of contact of each tool with the crankshaft. The angularity of the surface presented to the cutting tool also constantly changes. To compensate for such conditions, it is necessary to have the positions of the cutting tools gradually change to enable them to conform to the contour of the work and at the same time to maintain theoretically correct cutting positions relative to the angular surfaces of the work. This is accomplished by swinging the rocker arm and rotating the tool, these movements being controlled by cams, mounted on the upper and lower shafts which are directly connected to shaft *G* through gearing. Fig. 3 shows a complete rocker-arm unit consisting of rocker arm *H*, tool-block *I*, tool *J*, upper master cam *K*, lower master cam *L*, and two levers connecting the roller of the upper cam with a gear segment having teeth that mesh with teeth cut on the circular flange of tool-holder *I*. These members are in the relative positions they occupy when assembled. The illustration also shows the position of the tool relative to the surface being machined.

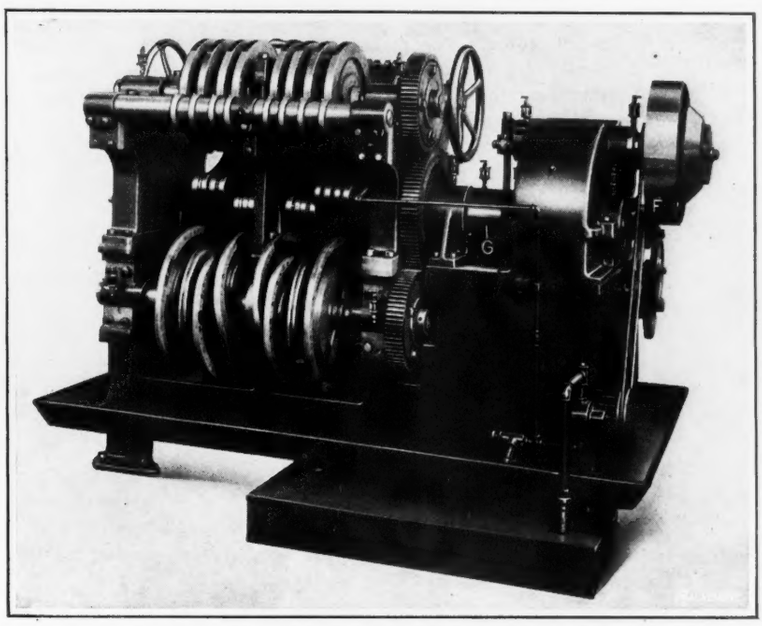


Fig. 2. Rear View of Crankshaft-cheek Turning Lathe showing Location of Master Cams

The large hole near the top of the rocker arm is provided for the over-arm. The cutting point of tool *J* is at the center of the tool-block and, this being the case, as the tool-block swivels to give the tool the proper cutting angle, the tool point itself remains in one position relative to the tool-block. Swiveling of the tool-block is accomplished by means of the upper cam and its roller, the motion of the latter being transmitted to the gear segment through the levers previously referred to. The form of the crank is obtained by swinging the rocker arm, the movement of which is controlled by the roller traveling in the track of cam *L*.

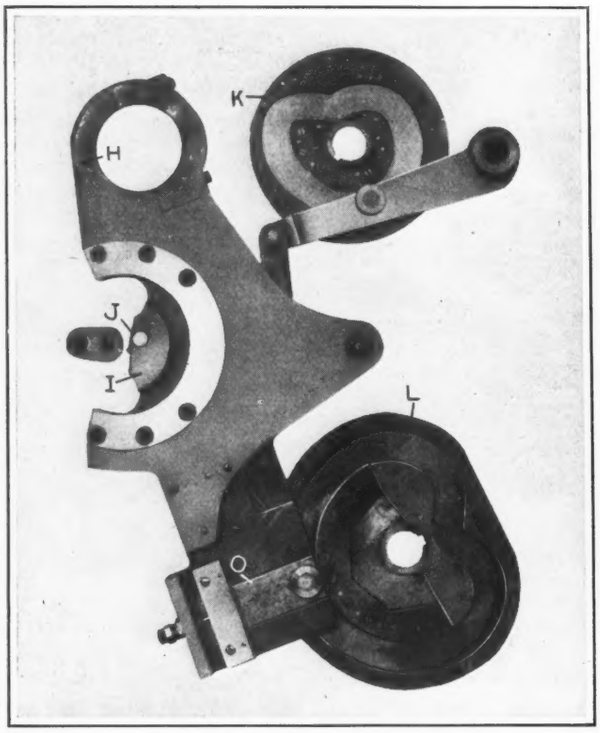
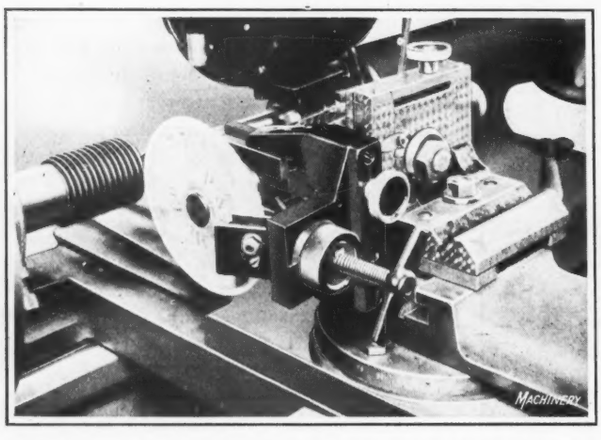


Fig. 3. Parts of the Rocker-arm Unit

Adjustments of the tool to suit different diameters are obtained through slide *O* at the bottom of the rocker arm, to which the roller of cam *L* is attached. The adjustments are made through a screw which may be locked in position. A gage provides for accurate resetting of the tool after it has been removed for regrinding. An adjustment at the tool point is effected through a worm in the tool-block which engages teeth cut on the tool.

PRECISION WHEEL-TRUING HEAD

The Precision & Thread Grinder Mfg. Co., 1 S. 21st St., Philadelphia, Pa., is now manufacturing the grinding wheel truing head here illustrated. In the illustration, the device is shown applied to the precision thread grinder made by this concern, but it may also be used as an auxiliary truing head on any grinding machine. The device is said to keep the wheel always in correct alignment with the thread being ground. It is feasible to dress the V-form on the wheel to a sharp point so as to facilitate the grinding of fine threads. There is no limit to the length of thread which may be accurately ground, because the wheel may be trued while grinding.



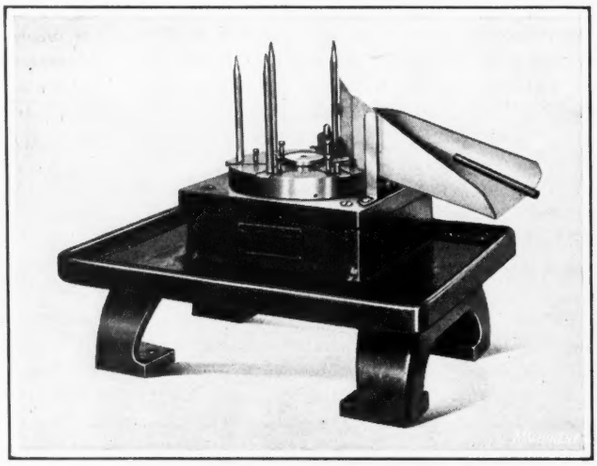
Two-diamond Grinding Wheel Truing Head made by the Precision & Thread Grinder Mfg. Co.

The mechanism for feeding the head has a dial graduated to 0.001 inch to enable the attachment to be fed forward sufficiently to make up for the reduction in wheel diameter by wear and dressing. The grinding wheel is trued by means of two diamonds, the form to which it is dressed being always in line with the axis of the work-centers. The diamonds are traversed by operating the double-ended handle on the extended screw, and they do not cut the wheel simultaneously but in progressive order; thus if one diamond becomes dull and the wheel springs away from it, the other and sharper one will not gouge the wheel.

When the diamonds become slightly worn, they can be rotated a fraction of a turn in order to present a new point to the wheel. The new point will always be sharp, and so the diamond can be worn down to its setting. A stop provided for regulating the return traverse of the diamonds can be utilized for predetermining the amount of flat produced at the bottom of the thread, thus insuring the same amount of flat, regardless of redressings and without subsequent regaging.

NOBLE & WESTBROOK TUBE-MARKING MACHINE

A marking machine produced by the Noble & Westbrook Mfg. Co., 19 Asylum St., Hartford, Conn., for marking names and patent marks on small tubes is here illustrated. The particular machine shown is employed for marking metal

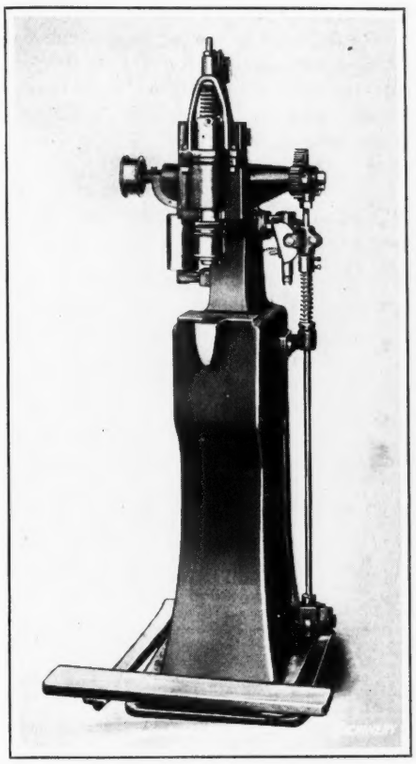


Small Tube-marking Machine which is a Product of the Noble & Westbrook Mfg. Co.

pencil tubes. The machine is driven by a three-step cone pulley from which power is transmitted to worm-gearing for revolving the table. The latter has six equally spaced mandrels upon which the work is placed by hand, and as the table revolves, the work is passed over a die which produces the desired marks on it. Then a cam raises a small lever that automatically removes the work from the mandrels and the machine. The possible production of this machine is over 10,000 marked tubes per day. The machine can be furnished for marking the ends of any size tubing in short lengths, and weighs about 90 pounds.

BLOMQUIST-ECK PNEUMATIC RIVETING MACHINE

The accompanying illustration shows a riveting machine built by the Blomquist-Eck Machine Co., 1146 E. 152nd St., Cleveland, Ohio. It consists primarily of a standard pneumatic hammer so mounted on the upright of the machine that it can be controlled entirely by a foot-treadle, leaving both of the operator's hands free to handle the work or the work-holding fixture in which the work is held. When the foot-treadle is moved downward, the hammer is brought



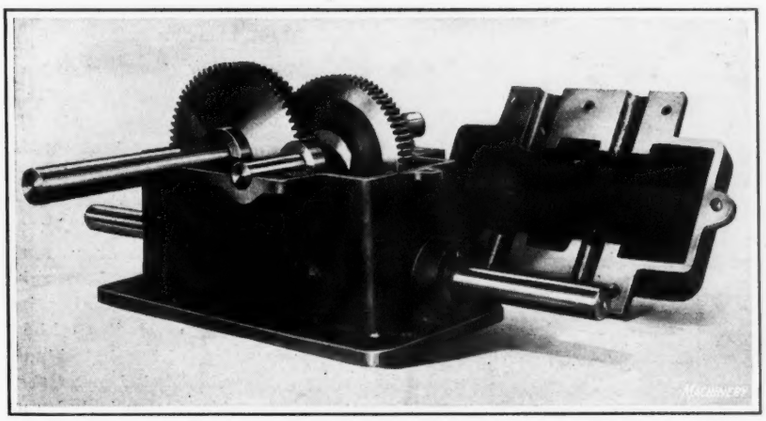
Riveting Machine which is a Recent Product of the Blomquist-Eck Machine Co.

down with it. This movement automatically turns on the air, the hammer then continuing to operate until the pressure on the foot-treadle is released. When that is done, the hammer is immediately returned to its upward position by a weight so attached that it counteracts the pressure of the foot-treadle.

As the hammer returns to the upward position, the air is automatically turned off. The air supply can be regulated by tilting the cam at the right-hand side of the machine, which controls the air throttle. The hammer slides within the carriage and is backed up by a spring at the top which absorbs the shock. While operating, the hammer is rotated by means of a belt passing over a pulley at its lower end. The machine illustrated has a pedestal designed with a special anvil or horn, but the anvils may be made to suit any condition and may be provided with vertical adjustment.

NATISCH GEARED SPEED TRANSFORMER

The speed of a driven shaft can be greatly reduced in relation to that of the driving shaft by the interpolation of a combined spur- and worm-gear transformer, which is made in various ratios between 1 to 75 and 1 to 1000, and for transmitting up to 5 horsepower, by the Natisch Gear Works, 451 Hudson Ave., Brooklyn, N. Y. The transformer illustrated is arranged to transmit ½ horsepower at a ratio of 1 to 600. The case is an iron casting of strong construction, and when the cover is assembled, is oil-tight and dust-proof. The design of all sizes of the transformer is similar, and for some ratios the same case is used, the change in ratio being accomplished by varying the number of teeth in the gears and the pitch of the worm and worm-wheel.



Combined Spur- and Worm-gear Speed Transformer built by the Natisch Gear Works

GENERAL ELECTRIC DIRECT-CONNECTED PLANER DRIVE

The General Electric Co., Schenectady, N. Y., has developed a new form of control which employs dynamic braking to prevent over-travel of direct-connected motor-driven planers either on reversal, through failure of voltage, or from other causes. The apparatus consists of a control panel on which are mounted the necessary rheostats and contactors, a resistance, a master switch or push-button, and a standard direct-current reversing adjustable-speed motor. The control is of two styles, one with a resistance selecting contactor and the other without. The remainder of the equipment, consisting of forward, reverse, and accelerating contactors, is the same in both cases.

The selective resistance contactor is connected to control the dynamic brake resistance in each direction of rotation, so that the resistor can be adjusted for one direction without affecting the adjustment in the other. A machine supplied with this control and geared for a table feed of from 25 to 50 feet per minute on the cutting stroke and from 50 to 100 feet per minute on the return stroke, with motor speeds of from 250 to 500 revolutions per minute on the cutting stroke and from 500 to 1000 revolutions per minute on the return stroke, can have the dynamic brake adjusted to give a maximum stopping effort at 500 revolutions per minute on the cutting stroke without regard to the return.

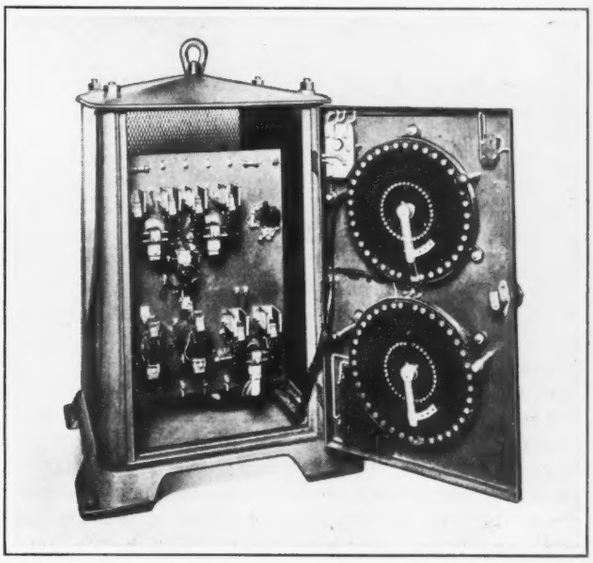


Fig. 1. Controller employed in Planer Drive developed by the General Electric Co.

Otherwise, if the resistance is adjusted for the maximum speed of 1000 revolutions per minute, the braking effort at 500 revolutions per minute will not be sufficient to stop the planer quickly on the return stroke.

One of the chief difficulties met with in planer drives is over-travel on reversal due to the contactor tips welding together under severe service conditions. In this new control the difficulty has been avoided by an arrangement whereby the welding of the contacts causes the planer to stop and will not allow it to over-run its set limits. Over-travel due to voltage failure and on reversal is taken care of by having the motor always connected to the dynamic brake. The utilization of dynamic braking, with a further refinement of the selective resistance contactor, makes it possible to jog the planer effectively by means of either the master switch or a push-button station. The switch or button, in jogging, can be operated in one direction, and when brought to the off posi-

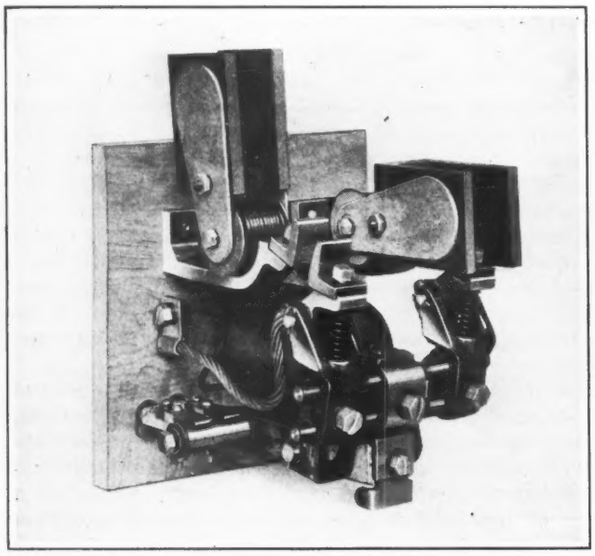


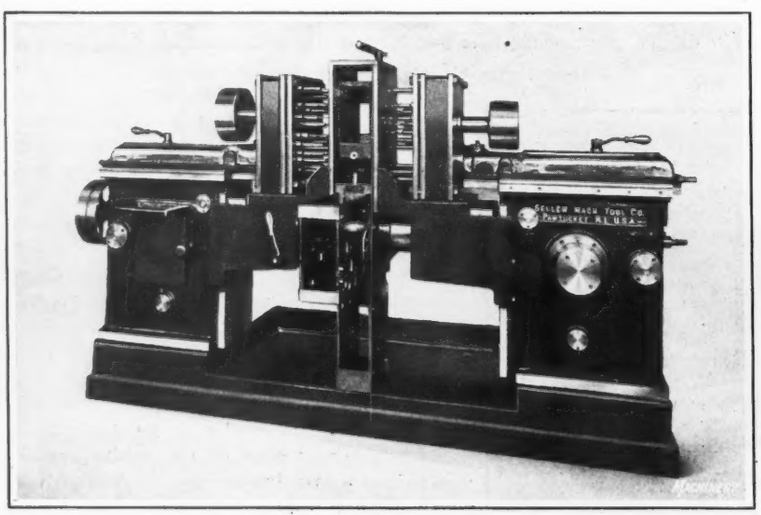
Fig. 2. View of Contactors showing Method of attaching Shunts

tion, the machine will stop. A machine equipped with the selective resistance contactor can be used on jobs having a small tool clearance, where the load varies from no load to full load and where cuts are made to the end of the planer travel.

SELLEW AUTOMATIC DRILLING MACHINE

An automatic drilling machine of the station type, having two horizontal heads, each of which contains a multiple number of drilling spindles, is a recent development of the Sellew Machine Tool Co., Pawtucket, R. I. In the accompanying illustration the machine is set up for drilling sixty holes in machine castings, 24 by 18 by 6 inches in size; however, it is also adapted for many classes of light drilling. Both heads are fed toward the jig and away from it simultaneously, the operation of the machine being continuous and automatic. The operator merely changes the work at the front station of the work-holding fixture and indexes this fixture through the stationary jig. An indexing takes place each time the drill heads are withdrawn from the jig.

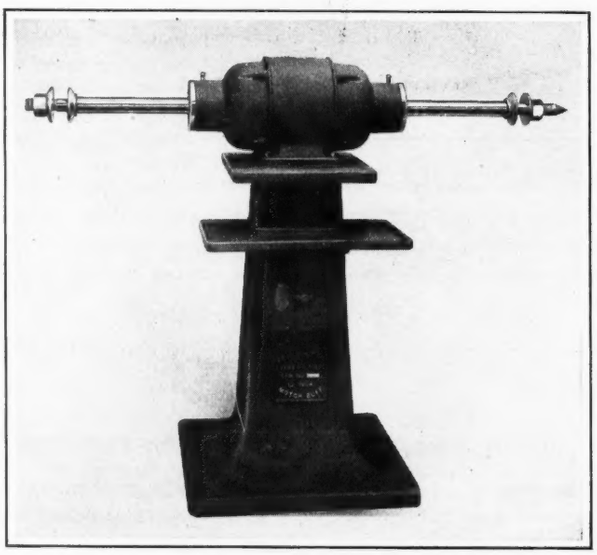
The drill spindles are mounted in radial and thrust ball bearings, and the individual spindles are run at speeds proportionate to the diameters of the drills attached to them. The feed of the drills, instead of being at a continuous rate, is eased as the drill enters the work and as it breaks through when the drilling is at an end, similar to a hand feed. The heads have a quick return. The head slides are arranged at their front ends to take different heads, and these can be changed quickly. The saddles provided on the table for carrying the jig are adjustable to accommodate a wide range of work. The machine is about 10 feet in over-all length, and weighs approximately 5000 pounds.



Automatic Multiple-spindle Drilling Machine built by the Sellew Machine Tool Co.

BLOUNT MOTOR-DRIVEN BUFFING MACHINES

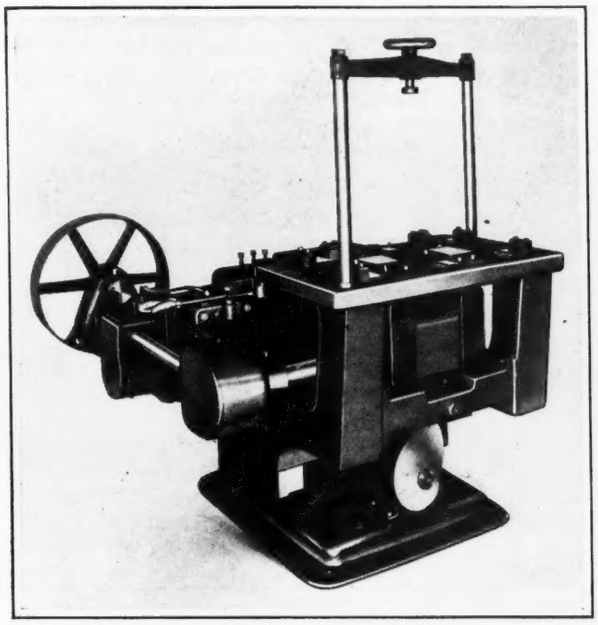
A line of alternating-current motor-driven buffing machines of the type shown in the accompanying illustration has been recently developed by the J. G. Blount Co., Everett, Mass. These machines are built in four sizes as follows: ½ horsepower, for 6- by ½-inch wheels; 1 horsepower, for 8- by 1-inch wheels; 2 horsepower, for 10- by 1½-inch wheels; and 3 horsepower for 12- by 2-inch wheels. Each machine is equipped with S K F ball bearings mounted in dustproof housings, and a snap switch having thermal cut-outs to afford protection for the motor. The spindle is made of high-carbon steel, and a taper point is fitted to the right-hand end so that the machine can accommodate small wheels. The head or motor unit is regularly mounted on a column with a pan, but it may also be supplied with a bench base when such a construction is preferable. The safety snap switch is placed on the column beneath the tool tray which serves to protect it from the buffing compounds used and from breakage or abuse. Westinghouse motors are supplied on this line of equipment.



Direct-connected Motor-driven Buffing Machine built by the J. G. Blount Co.

NEWTON STRADDLE-MILLING MACHINE

A recent development of the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa., is the cycle-feed Model C-75 straddle-milling machine here illustrated. The particular machine shown was built for facing the crankshaft bearings of automobile cylinders. It may be driven by a belt connecting either to a motor or a countershaft, the drive being transmitted through gears enclosed to permit their running in oil. The machine has two spindles which are mounted in housings having individual end adjustment to permit regrinding of the milling cutters. The table motion includes a rapid advance downward, a slow feed while



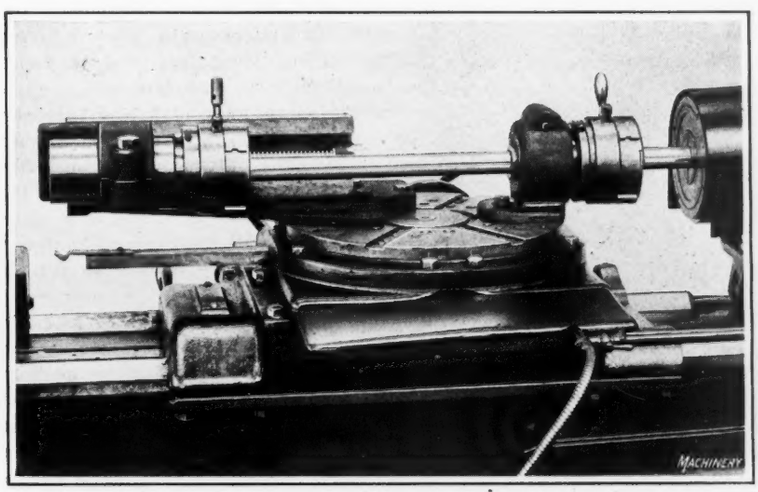
Model C-75 Straddle-milling Machine which has been recently designed by the Newton Machine Tool Works, Inc.

the cut is taking place, and an upward quick return. It automatically stops at the loading position which may be on a level with the conveyor rolls. Provision is made so that the rate of feed or the time required for the cycle of one operation may be increased or decreased to suit the material being machined. The table is provided with hardened steel jig plates. The work is clamped from above by a double-post beam clamp that is hinged at one end and supplied with a central clamping screw operated by a handwheel.

CINCINNATI-ACME TURRET LATHE STAYBOLT ATTACHMENT

Of particular interest to the railroad field is the staybolt attachment here illustrated which is manufactured by the Acme Machine Tool Co., Cincinnati, Ohio, for use on the Cincinnati-Acme flat turret lathes manufactured by this concern. The equipment has two die-heads which cut a thread simultaneously on opposite ends of the staybolt. The dies should be set from a master or staybolt tap to insure that the two threaded portions will have one continuous lead. The rear die-head can be adjusted to accommodate various lengths of staybolts.

When using bar stock, a roller back-rest multiple-turner is employed to turn the bolt to the proper diameter for the threads, a recessing slide being used in turning the relief.



Staybolt Attachment for Flat Turret Lathes built by the Acme Machine Tool Co.

Both die-heads are used to cut the thread, the staybolt being finally severed from the bar by a cutting-off tool. When threads are to be cut on forged staybolts, the bolts are forged to the correct thread and recess diameters and length, when a continuous lead is desired, and both die-heads are used simultaneously, as when threading bar stock. The attachment is made in three sizes for staybolts from 1¼ to 1½ inches in diameter. The maximum length of staybolt which can be turned and threaded at one chucking varies with the sizes from 25 to 36 inches. When the staybolts can be threaded without a thread-lead relation, it varies from 48 to 71 inches.

PRATT & WHITNEY DIE-SINKING MACHINE

A new die-sinking machine incorporating unique features in its design that particularly adapt it for handling large dies, has been brought out by the Pratt & Whitney Co., Hartford, Conn. Through the medium of two "Bayrer's" compensating arms, dies up to 4 tons in weight can be suspended by elevating screws, and readily placed in position on the table. These arms also make it easy for the operator to swivel, tilt, or turn large work on edge. The hand feeds are thereby rendered sensitive to light cuts, and the die may be fed over to extreme limits for cutting gates, without cramping. In Fig. 1, the compensating arms are folded back against the sides of the column. The arms are carried on roller bearings supplemented by ball bearings, and are therefore sensitive to any movement of the die.

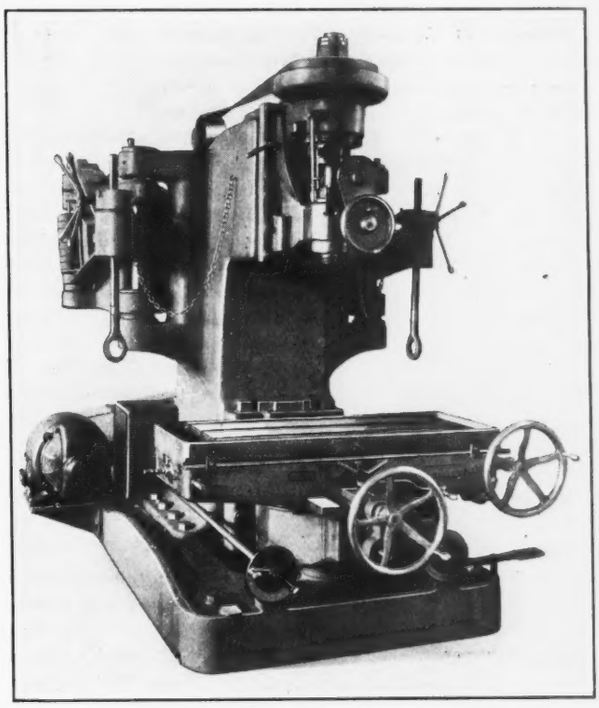


Fig. 1. New Large-size Die-sinking Machine brought out by the Pratt & Whitney Co.

Fig. 2 is another front view of the machine, showing the arms extended to support a die that has been swiveled on the table and moved into position for taking a cut near the end of the die. Both carrying arms are provided with balance beams and adjustable weights by means of which the weight of the die can be approximately balanced and relieved from the table. The holding members attached to the ends of the

die act as trunnions on which it may be readily tipped on its side for edge cuts. When the die is being tipped on its side, the table is dropped clear of it, and consequently the arms sustain the entire load. Dies of various thicknesses may be adjusted to a convenient level for the operator.

The cutter-spindle is mounted in a counterweighted vertical head having a hand feed with a graduated dial. A rapid traverse enables the head to be adjusted quickly. Power is transmitted to the cutter-spindle through a quarter-turn belt connected to the gear-box at the rear of the machine. All changes of speeds and feeds are effected by levers placed at the front of the machine for the convenience of the operator. Both hand and power feeds are supplied for the longitudinal and cross feeds of the table and, in addition, a rapid power movement is provided for all table traverses, including elevating and lowering. The mechanism that actuates the power movements operates from a friction clutch that prevents injury to parts in case the members are fed too far.

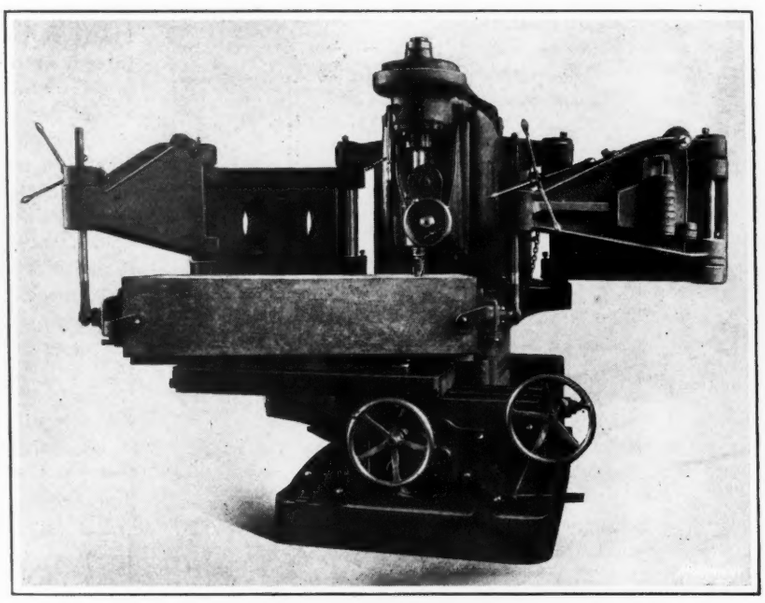
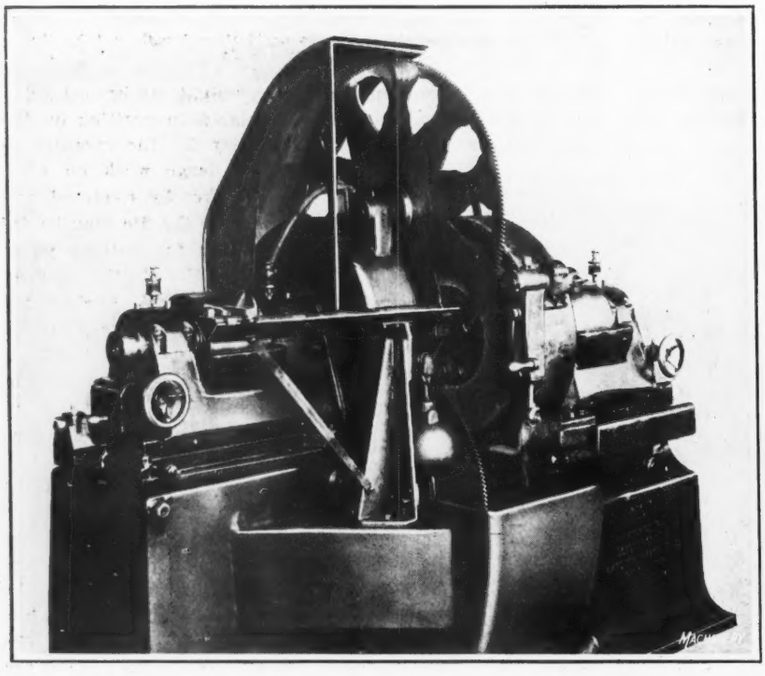


Fig. 2. The Pratt & Whitney Die-sinking Machine with the Arms extended

A cherrying attachment may be readily applied to the cutter-head and driven through gearing connected to the nose of the spindle. When not in use, the cherrying attachment may be swung out of the way so as not to interfere with the use of the machine on other work. This die-sinking machine may be equipped for either a constant-speed drive direct from a lineshaft or from a motor mounted on the machine. It is also built without the die-carrying arms when these are not required. The main dimensions are: Size of table top, 22 by 48 inches; longitudinal feed of table, 48 inches; cross-feed of table, 17 inches; vertical feed of table, 15 inches; and vertical feed of cutter-head, 12 inches. The weight of the machine is approximately 16,000 pounds.

GARDNER AUTOMATIC DOUBLE-SPINDLE GRINDING MACHINE

A machine designed for the rapid and simultaneous grinding of two opposite parallel sides of a piece, which differs from ordinary double-spindle disk grinding machines in a number of respects, is here illustrated. This machine is of the continuous-feed type, and has been developed and placed on the market by the Gardner Machine Co., 414 Gardner St., Beloit, Wis. The two spindles are offset in relation to each other, and for wet grinding the driving members consist of 24-inch diameter abrasive ring-wheels which are carried in chucks designed particularly for this type of machine. For dry grinding 24-inch steel disk wheels faced with abrasive disks, are used.



Gardner No. 1 Automatic Double-spindle Grinding Machine

The parts to be ground are carried to the cutting position by a carrier that passes between the grinding wheels. For the purpose of accommodating a wide range of work, from pieces having a large surface requiring the removal of considerable stock to pieces with small areas over which only a slight cut is to be taken, the carrier is provided with a feed varying from six to forty pieces per minute. This carrier has a number of openings to receive the work. As the work approaches the grinding position one of the grinding wheels automatically advances until it reaches a positive stop. It approaches the work under an adjustable stroke pressure, and, consequently, advances only as rapidly as stock is removed. Thus constant pressure is maintained against the work. The wheel is returned to the open position by a cam, and the work is automatically unloaded as it passes from between the wheels. The cam referred to also governs the spring pressure feed. Provision is made for aligning the two spindles and an adjustment of the grinding members is obtained by a handwheel operating through worm-gearing and a screw, this handwheel being graduated to 0.0001 inch to permit close adjustments.

When grinding work of a size that permits operation of the machine at the higher rates of feed, the automatic feeding device is of material assistance in keeping the work-carrier loaded at all times, as it practically eliminates all hand labor. However, in cases where larger work necessitates the operation of the machine at the lower feeds, it is usually more economical to feed the carrier by hand. Devices for truing the grinding members are an integral part of the machine. Although these are so located that they are ready for use at all times, they do not interfere with the operation. Among the parts for which this machine is particularly adapted, are piston rings, ball and roller bearing races, adding machine parts,

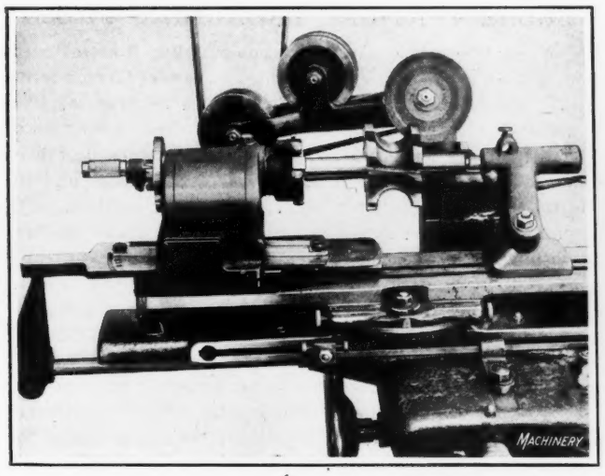


Fig. 1. "Curvex" Cutter and Hob Grinding Attachment made by the R. K. LeBlond Machine Tool Co.

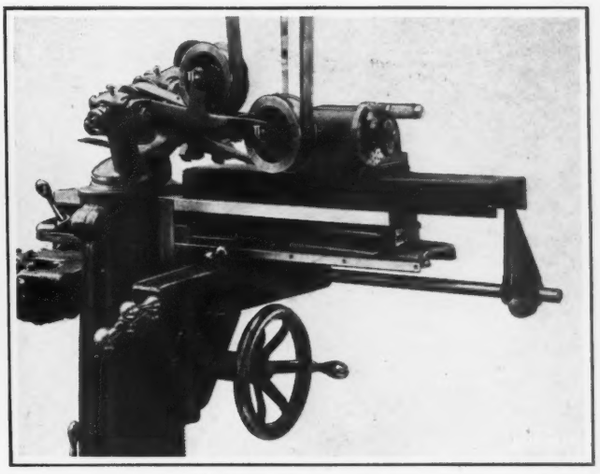


Fig. 2. Rear View of Cutter and Hob Grinding Attachment, showing Angular Raising Block

thrust washers, gear blanks and similar pieces. The openings in the work-carrier may be made to conform to the shape of practically any such piece. The holes in the particular carrier shown were made for ball bearing races, but by means of metal inserts they have also been used for conveying other pieces.

BLACK & DECKER PORTABLE DRILL

A half-inch portable electric drill having the familiar pistol grip and trigger switch used on other portable drills manufactured by this concern, which have previously been illustrated and described in MACHINERY, is being placed on the market by the Black & Decker Mfg. Co., Towson Heights, Baltimore, Md. The grip is placed beneath the housing, and the current connection is at the lower end of the grip. A three-jaw chuck for holding straight-shank drills up to ½ inch is provided with the equipment. The switch cover plate may be quickly removed to expose the terminal block to which the electric cable and motor leads are attached by means of screw terminals. The net weight of this tool is approximately 15 pounds.

LEBLOND CUTTER AND HOB GRINDER ATTACHMENT

An attachment lately developed by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, for use on the universal tool-room grinding machine built by this firm, facilitates the grinding of "Curvex" milling cutters made by the Pratt & Whitney Company, and of spiral hobs. In grinding a "Curvex" cutter, the cutter is mounted on an arbor between the centers of the attachment, as shown in Fig. 1, the table is set to zero, and, from a chart of leads and angles, the taper guide bar of the attachment is set to the required angle. Although this guide bar is shown exposed in this illustration, it is ordinarily protected by a cover, as will be seen in Fig. 2. As the table of the grinding machine is fed horizontally, the cutter-spindle is automatically revolved in the proper relation to the lead and spiral angle. The cutter is indexed by the plunger and index-plate to bring each tooth to the grinding plane.

The wheel-head is mounted on an angular raising block, as shown in Fig. 2, to bring the wheel-spindle to an angle of 15 degrees from the horizontal. A special grinding wheel is used, the front face of which is dressed vertically to insure a single line of contact between the wheel and the work. This enables the work to be fed vertically to the wheel. The knee is swiveled to an angle corresponding to the helix angle of the cutter, and the table traversed past the wheel by the rack and pinion. The grinding plane is always on a true radial line from the center of the cutter, and the wheel always clears itself in the work.

The wheel is dressed on the face by clamping a diamond on the table and using the vertical feed. Fig. 2 also shows the belt sheaves provided for aligning the belt when using an angular raising block; this equipment is not required in grinding spiral hobs.

MURCHEY NIPPLE REAMING AND CHAMFERING MACHINE

The front view of a nipple reaming and chamfering machine, and a close-up view of the chuck and reaming and chamfering tools are shown in Figs. 1 and 2. This machine is a recent product of the Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich. The piece of pipe being operated upon is held in the chuck jaws, which are opened by the manipulation of a foot-lever, and automatically closed when pressure is released from the lever. The jaws are hardened and ground. The chuck unit slides on wide bearings, and centers itself as the tools begin to cut. After a nipple has been machined, the operator pushes it from between the jaws as he inserts a

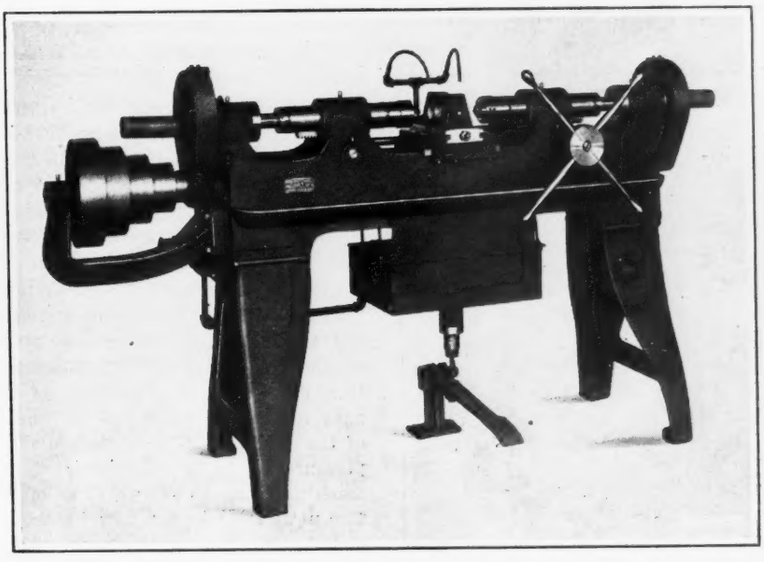


Fig. 1. Nipple Reaming and Chamfering Machine made by the Murchey Machine & Tool Co.

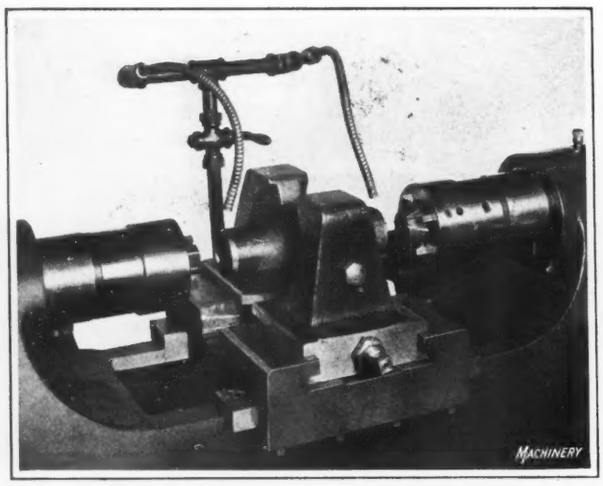


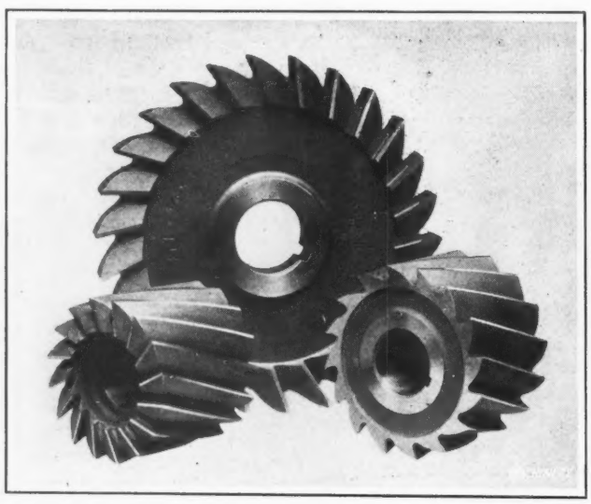
Fig. 2. Close-up View of Chuck and Reaming and Chamfering Tools

new piece, the finished nipple dropping into a receptacle. The countershaft of the machine is arranged with right- and left-hand pulleys, while four-step cone pulleys give a selection of four speeds. A pump provides for an adequate supply of lubricant to the work. The machine is suitable for pipe of all sizes from ⅛ inch to 2 inches, and will handle lengths up to 12 inches. It weighs about 1200 pounds.

While primarily designed for the reaming and chamfering of nipples, the machine can also be equipped with die-heads for threading nipples made from ⅛- to ¾-inch pipe. It may also be employed for threading tees, valves, studs, and other parts requiring a thread on both ends. The opening and closing of the die-heads is automatic.

"PARABOLIC" MILLING CUTTERS

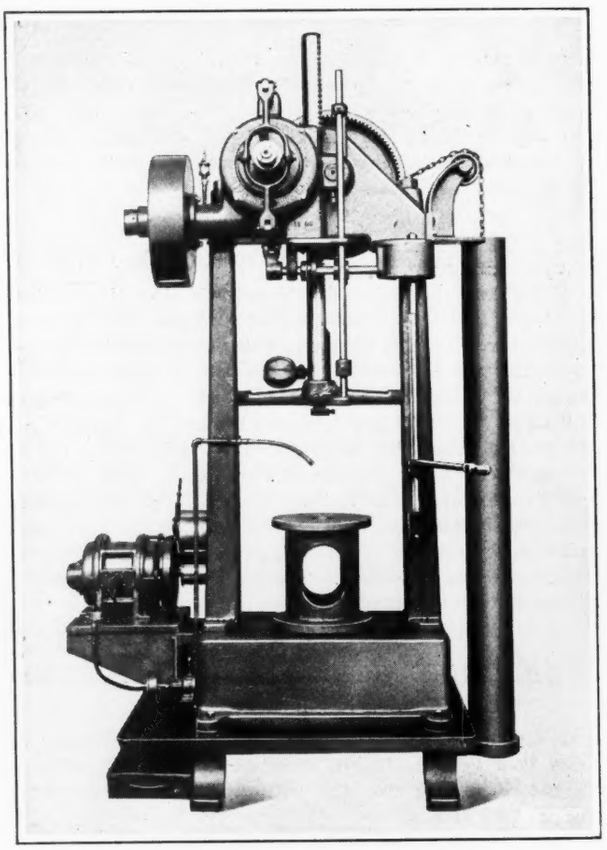
As the result of several years of research, the National Twist Drill & Tool Co., Detroit, Mich., has placed on the market a new type of milling cutter known as the "Parabolic," three examples of which are here illustrated. This name was selected to characterize the distinctive construction of the teeth. The tests indicated that in order for a milling cutter tooth to be of uniform strength throughout its length, its shape should be that of a parabola, slightly modified at the small end, and so this shape was adopted for these cutters. The number of teeth is nearer to that of the conventional fine-tooth cutter than to that of the coarse-tooth type. In order to obtain an efficient chip thickness per tooth without an excessive peripheral speed, a fairly large number of teeth was found desirable. This cutter is made in plain side and end-mill types, as well as for special purposes.



"Parabolic" Milling Cutters manufactured by the National Twist Drill & Tool Co.

LUCAS VERTICAL BROACHING PRESS

The machine shown in the accompanying illustration is a modification of the general-purpose power forcing press which has been manufactured by the Lucas Machine Tool Co., Cleveland, Ohio, for a period of more than twenty years. The utility of the machine for repetition work has been enhanced by an increase in the speed of the stroke and the addition of a quick-power return and lever control. The machine is especially adapted for vertical push-broaching operations. The working elements consist of a ram to which motion is transmitted by gearing controlled by a friction clutch which engages a worm-wheel driven by a worm on the pulley shaft. The operating lever for controlling the clutch is adjustable vertically on the rod in front of the right-hand column so that it is within convenient reach of the operator, whether he is standing or sitting. Movement of this lever to the left engages the clutch and causes the ram to start on the down or pressure stroke. The ram



Vertical Press of Modified Design placed on the Market by the Lucas Machine Tool Co.

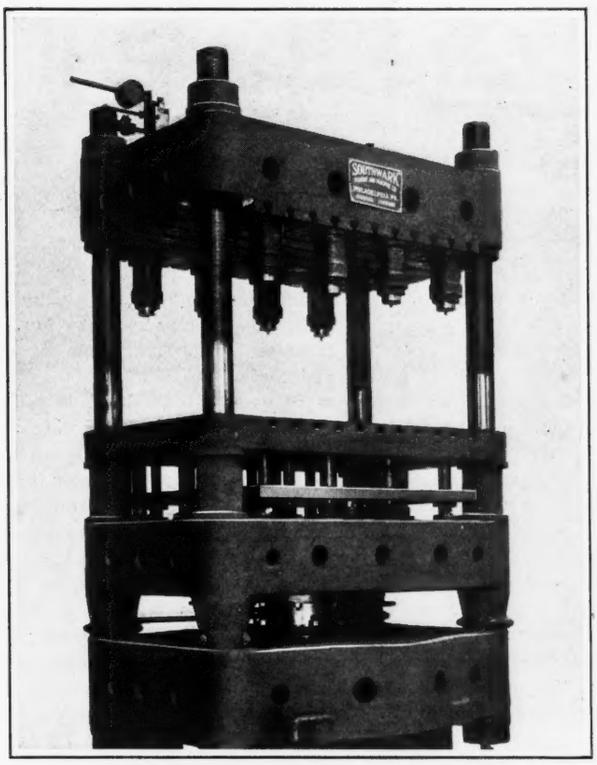
descends until the upper trip on the rod in front of the ram strikes a dog on the horizontal shaft. This shaft is connected by bevel gears with the vertical shaft to which the operating lever is attached, and thus stops the downward movement of the ram.

Movement of the operating lever to the right causes the ram to start on its return stroke at a quick rate of speed, which continues until the lower trip strikes the dog on the horizontal shaft. Both trips are adjustable vertically on the rod so as to stop the ram at predetermined points. The number of strokes the ram makes in any given time, therefore, depends upon the length of the stroke. A graduated gage registers the pressure in tons up to the rated capacity of the machine. The friction drive can be adjusted to any pressure up to the maximum capacity of the press. The machine is made in two sizes of 15 and 30 tons capacity. The net weight of the 15-ton machine is approximately 2900 pounds, and that of the 30-ton machine, 3800 pounds. The 15-ton press is driven by a 7½-horsepower constant-speed motor, and the 30-ton press by a 10-horsepower motor.

SOUTHWARK HYDRAULIC AUTOMOBILE-BODY PRESS

The Southwark Foundry & Machine Co., Philadelphia, Pa., has recently developed a press for the production of all-steel automobile bodies. The general construction of this machine will be apparent by reference to the illustration. The press has a capacity of 450 tons. The main ram is located in the lower base to which are secured four columns. The press is provided with clamping and stripper platens. The stripper platen carries four hydraulic cylinders acting upon a forged steel plate which, in turn, has sixty stripper pins, 1½ inches in diameter. These pins project through the clamping platen, which is a solid steel casting and is provided with T-slots.

The top platen carries eight hydraulic jacks having 5-inch diameter rams and strokes of 5 inches, these jacks being employed to accomplish the clamping. This platen is adjustable to accommodate the various sizes of dies which it may

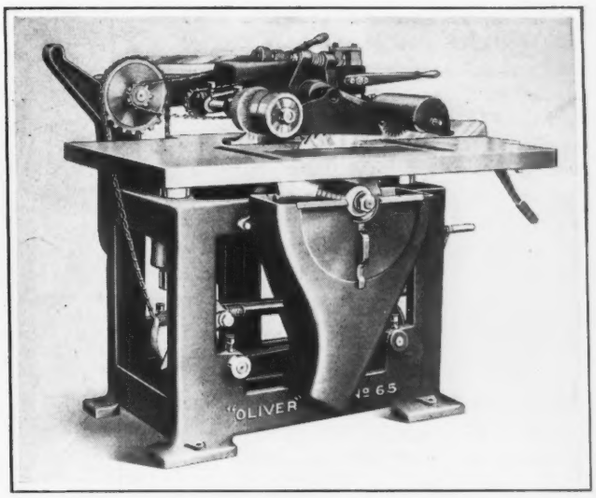


Hydraulic Automobile-body Press made by the Southwark Foundry & Machine Co.

be desired to employ with the press. The machine operation is controlled by a single lever; this lever operates a valve which subjects the four hydraulic cylinders and the main ram to a low pressure, and as soon as the dies have come together, high pressure is applied through the steam operating valve to complete the operation. The clamping cylinders are automatically controlled from a low-pressure filling tank, and are capable of standing a pressure of 5000 pounds per square inch. The press has a die space of 7 by 5 feet, a minimum vertical opening between the platens of 18 inches, and a maximum opening of 4 feet.

OLIVER SELF-FEED RIP SAW

Safety provisions and a dust chute are the principal new features on the No. 65 self-feed rip saw brought out by the Oliver Machinery Co., Grand Rapids, Mich., which is an improved design of other machines sold by this company. The machine is intended for ripping all kinds of lumber and may be used for rough as well as for finished stock. The saw arbor is mounted on a frame having a vertically



Self-feed Rip Saw now being placed on the Market by the Oliver Machinery Co.

adjustable table with an in-feed roller which may be either corrugated or smooth, according to the requirements of the work. This roller carries the stock through the saw and across the table. A gang of six saws separated by 1-inch spacing collars may be used at one time. Three rates of feed are provided, 80, 110 and 140 feet per minute, respectively.

The features of the machine include a quick adjustment for the feed rollers, quick adjustment and locking of the ripping fence, and quick vertical table adjustment. The machine has a mechanism that absorbs shocks on the feed rollers and overcomes any jerks produced in starting the stock through the machine. The lower portion of the saw is adequately guarded by means of the dust chute and a cover, while the upper portion runs in another guard. The feed rollers are also covered by metal guards to eliminate accidents while feeding the machine. This saw may be arranged for either a motor or countershaft drive. It will accommodate saws up to 18 inches in diameter, will cut lumber up to 5 inches in thickness, and rip pieces up to 24 inches in width.

"PAKFULL" SECTIONAL FILING EQUIPMENT

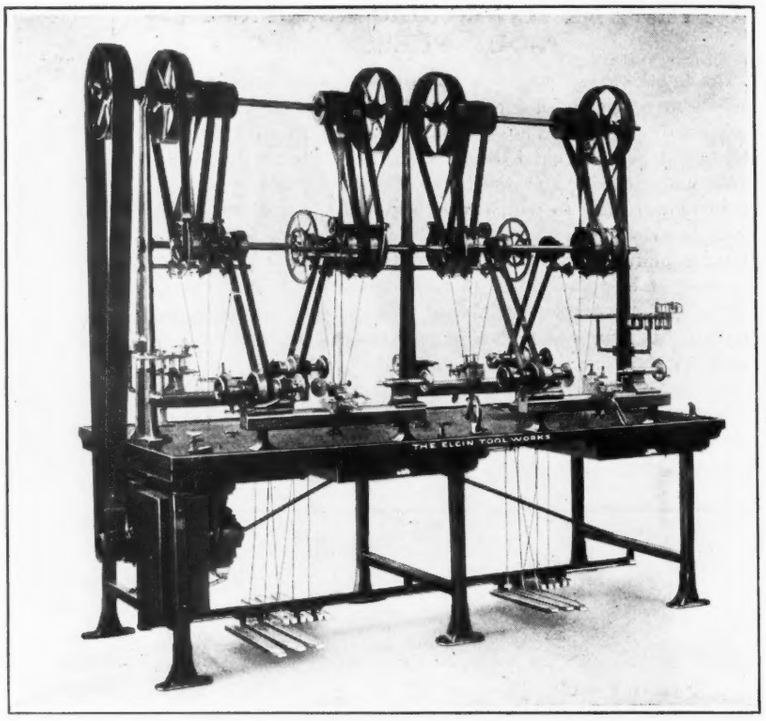
Two five-drawer sections of a filing case made by the Economy Drawing Table & Mfg. Co., Adrian, Mich., for filing tracings and blueprints are shown in the accompanying il-

Sectional Filing Case made by the Economy Drawing Table & Mfg. Co.

lustration. Between each drawer is a frame, on the under side of which is a piece of heavy paper that is flush with the bottom of the frame so that the drawer enters a pocket. The sides of the drawer extend upward into the frame a sufficient distance to keep the contents from sliding over the top of the drawer on either side, while two dowels at the back, which protrude upward into the frame, keep the contents from sliding over the back and into the rear of the cabinet. When the drawer is closed the front comes up against a groove in the frame, so that it is dustproof. The cabinet can be furnished with drawers either 26 by 38 by 2 inches or 32 by 44 by 2 inches, inside measurements.

ELGIN BENCH-LATHE UNIT

The accompanying illustration shows a unit consisting of four bench lathes, countershafts, jack-shaft, driving motor, and bench, which is being introduced to the trade by the Elgin Tool Works, Inc., Elgin, Ill. This unit may be supplied with either the regular No. 4 or No. 4 by 5 lathes manufactured by this concern and two- or three-speed countershafts. The motor can be furnished for operation on either alternating or direct current. The belt-shifters are operated through foot-treadles. The bench is made of kiln-dried hardwood and furnished with a tool drawer and collet rack for each lathe. Although the machine illustrated is equipped with four lathes, it can be provided with a larger or smaller number.



Four-machine Bench-lathe Unit built by the Elgin Tool Works, Inc.

HARRINGTON MULTIPLE-SPINDLE DRILLING MACHINE

A No. 19 multiple-spindle drilling machine of the rail type, on which the spindle heads have not only a longitudinal movement on the cross-rail but also an in-and-out movement on arms mounted on the rail, has been added to the line of machines built by Edwin Harrington Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa. An advantage of this design is that it enables irregularly located holes to be drilled, permits close center distances, and has a relatively large in-and-out movement. The machine illustrated in Fig. 1 has three spindles, although four are usually provided. The machine is designed to transmit 25 horsepower which is considered ample for driving four 2-inch drills at ordinary speeds and feeds.

The in-and-out movement of each spindle head is independent of the others, and is effected through a ratchet-operated screw. Each spindle is provided with a counterweight, and a clutch on the driving gear allows any spindle to be stopped independently of the others. The heads are moved along the cross-rail by revolving a pinion that engages a rack on the rail, this pinion being rotated by turning the squared end of a shaft extending to the outer end of the arm. Another shaft located above this traversing shaft operates the arm-clamping device. Simultaneous feeding of the different spindles is controlled from the right-hand end of the machine, while separate feeding of any spindle is governed at the end of its corresponding arm. The feeding mechanism is driven by a belt from the top shaft, through change-gears and worm-gearing. By turning a handwheel, quick vertical movements of the spindles are obtainable. The several spindles are fed together through the medium of a clutch located at each arm. A handwheel provides for moving the spindles up and down independently or for setting them to the proper height when the universal feed is used. Automatic stops that disengage the spindles at any predetermined point are provided for use with the individual feed.

When the machine is driven from a countershaft, two-step cone pulleys and back-gears provide four spindle speeds. When an adjustable speed motor is employed for driving the machine, a single pulley is supplied, and

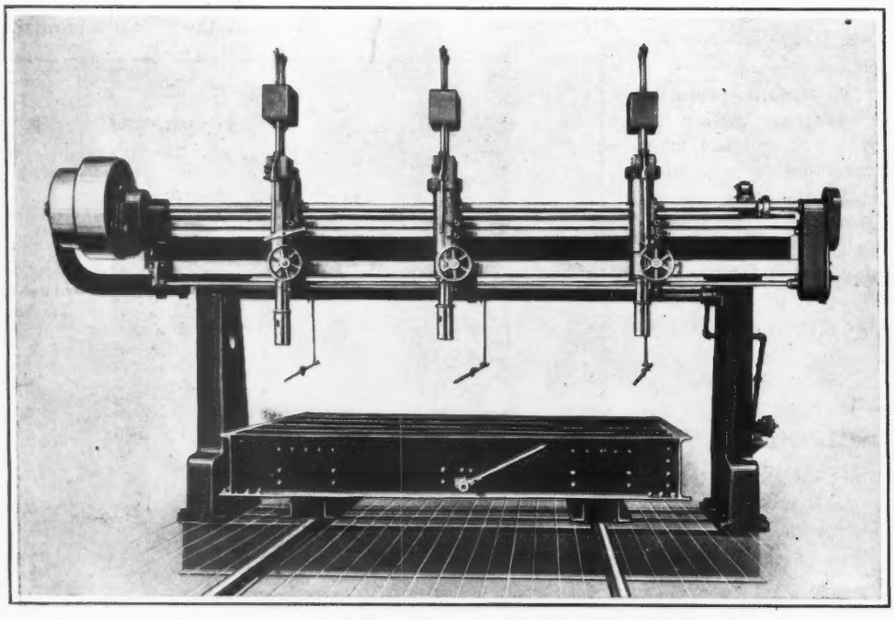


Fig. 1. No. 19 Multiple-spindle Rail Drilling Machine built by Edwin Harrington Son & Co., Inc.

when a constant-speed motor is used, the motor is placed on top of the machine and the countershaft mounted in a frame fastened to one upright. A speed-gear box can also be furnished in place of the countershaft. For large work a truck table made of structural steel, as illustrated, is generally considered best. This table is fitted with wheels to travel on tracks placed on the floor level, and can be readily moved by the use of a ratchet lever, although a power movement through an individual motor can also be provided. For other work a stationary table of structural steel may be preferable. Cast-iron tables with finished surfaces of various areas and arranged either to slide or roll are also applicable by providing the uprights with proper guides. A pump and distribution manifold furnish a continuous supply of cutting lubricant to the drills through universal-joint outlet pipes.

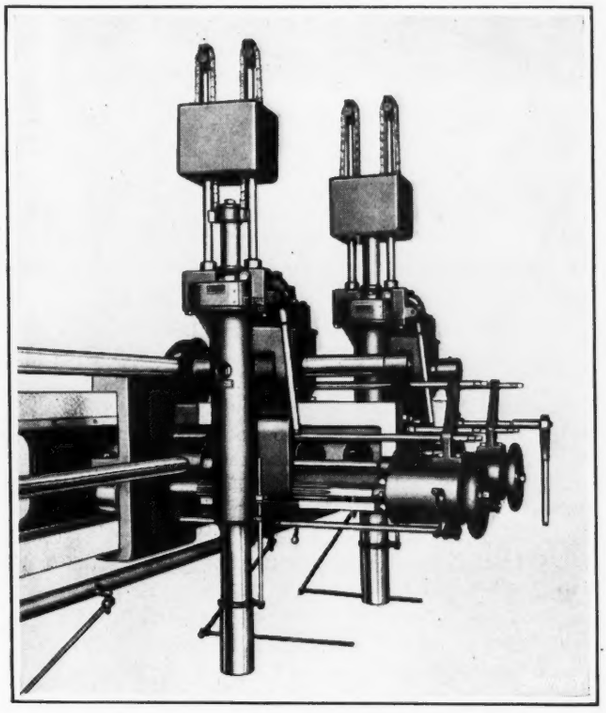


Fig. 2. Close-up View of Spindle Heads showing Construction of Mechanism governing In-and-out Movement

ECLIPSE INTERCHANGEABLE SPOT-FACER AND COUNTERBORE

The accompanying illustrations show assembled and disassembled views of an interchangeable spot-facer and counterbore known as the "Junior," which is manufactured by the Eclipse Interchangeable Counterbore Co., 7410 St. Aubin Ave., Detroit, Mich. The complete tool consists of a nickel-steel holder, an externally and internally threaded nut, a high-speed steel spot-facer having milled flutes, and a machine-steel pilot. The cutter is aligned accurately with the holder by means of a ground boss that snugly fits a hole in the holder. The nut is screwed into the holder by means of its external threads, and serves two purposes. First, it enables instant removal of the pilot in case of breakage, and second, by quickly changing it for one with a smaller internal thread, the same holder may be used with different pilots and cutters. The end of the pilot head is provided with a slot to receive the end of a screwdriver, and flats to facilitate its removal by means of a plier or wrench. The spot-facing tool may also be used with standard Eclipse holders and pilots through the use of an adapter. The spot-facer is made in various sizes, from ½ to 3 inches in diameter, and the shank of the holder is made with a No. 2, 3, or 4 Morse taper. Spot-facers can also be supplied without the pilot.

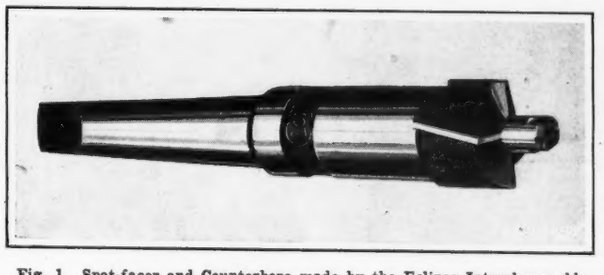


Fig. 1. Spot-facer and Counterbore made by the Eclipse Interchangeable Counterbore Co.

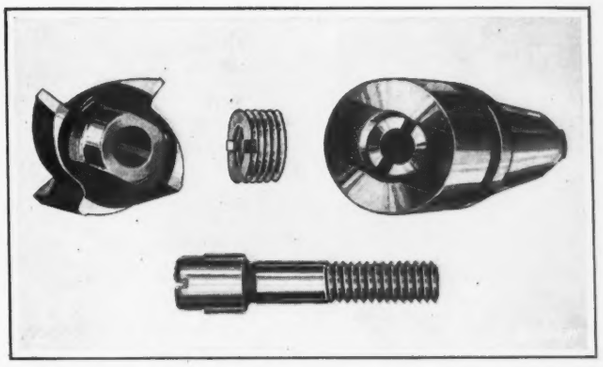
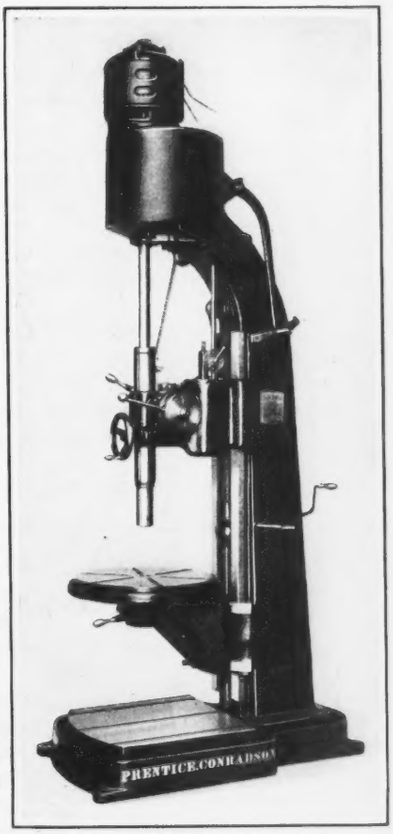


Fig. 2. Disassembled View of the Tool illustrated in Fig. 1

CONRADSON UPRIGHT DRILLING MACHINE

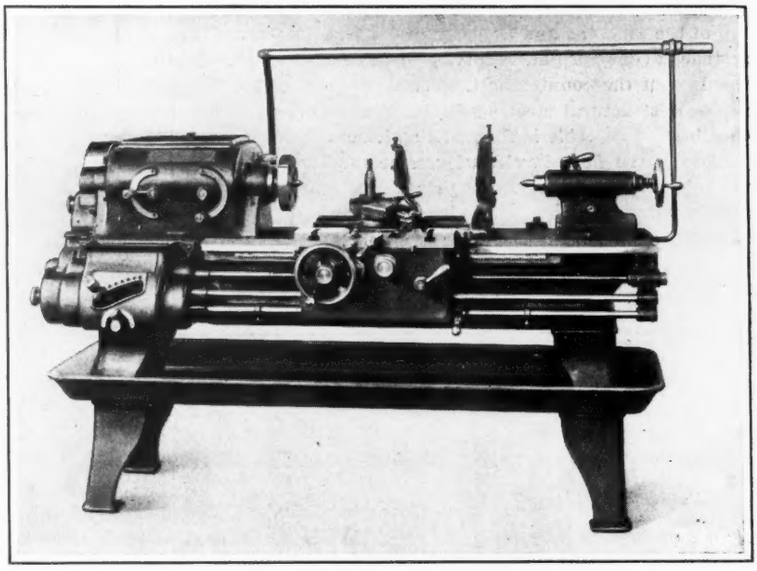
A 32-inch upright drilling machine driven from a motor mounted at the top of the column and connected to the spindle through gears is built by Prentice Conradson, Green Bay, Wis. The armature shaft of the motor consists of a hollow sleeve into which the upper end of the spindle extends, but the spindle is not fastened to this shaft. On the lower end of the armature shaft is mounted a gear from which the drive is transmitted to the spindle through the plain and sliding cluster gears contained in the column just beneath the motor. Nine speed changes are obtainable, while the feeding mechanism provides for six feeds ranging from 0.006 to 0.035 inch per spindle revolution.



Upright Drilling Machine built by Prentice Conradson

The table has the usual adjustments, and a rectangular or sliding table can be supplied instead of the circular table shown, if desired. A reversing motor is provided for tapping. Alternating- or direct-current motors can be supplied, a 3-horsepower motor being recommended for ordinary work, and a 5-horsepower motor running at 1800

revolutions per minute for rapid work. The controller furnished with the machine protects the motor against accidental over-loads. Some of the specifications are as follows: Maximum distance from base to spindle nose, 56 inches, and minimum distance, 15½ inches; vertical traverse of table, 16 inches; and maximum distance from table to spindle nose, 37 inches. The machine has a capacity for driving a 3-inch high-speed drill through steel, and weighs about 3700 pounds.



New 14-inch Tool-room Lathe built by the Rockford Tool Co.

SUNDSTRAND TOOL-ROOM LATHE

A 14-inch tool-room lathe driven either through a cone pulley or a geared headstock is a recent product of the Rockford Tool Co., 2400 Eleventh St., Rockford, Ill. The machine illustrated is equipped with the geared headstock. All gears in the headstock are submerged in oil, and sliding gears are used exclusively. The spindle speeds range in geometrical progression from 13 to 326 revolutions per minute, and all speed changes can be made while the machine is in motion. The headstock has a friction clutch designed to stop the spindle immediately when the clutch is disengaged. Oiling of the spindle bearings is accomplished from a reservoir.

The quick-change gear-box has a tumbler and a cone of eight gears, which can be set to run at different speeds by the lower lever on the feed-box. By this arrangement forty-eight different threads and feeds are obtainable. By shifting the position of an intermediate slip gear located beneath the spindle, the feed-box may be disengaged. A number of special threads can be obtained without the use of extra gears; however, the design of the feed-box is such that any special thread may be cut by furnishing the proper gears.

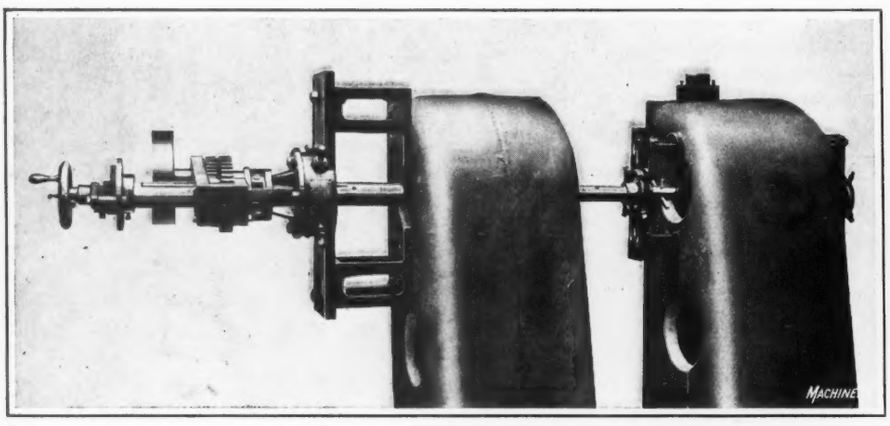
The apron is of box construction with all gears enclosed by a plate on the rear side. The rack pinion may be disengaged from the rack when desired. The apron is provided with a sensitive clutch for throwing in both the longitudinal and the cross feeds. A separate feed-rod and a reversing rod are provided. Reversing of the feeds is effected by a lever conveniently located on the right-hand end of the apron. With this construction it is convenient for the operator to set the feed instantly to neutral or reverse. Collars can be placed at certain positions on the reversing rod for stopping the carriage automatically at desired points. This possibility is especially convenient in cutting threads.

The lead-screw is connected directly to the cone of gears in the feed-box and has end thrusts taken up by ball bearings at the tailstock end of the lathe. Micrometer stops are regularly furnished for the cross-slide. The tailstock is clamped by a device at the back having a handle which is conveniently operated from the front. Boring and counterboring operations are facilitated by the provision of a collar on the tailstock which is graduated to 0.001 inch. The relieving attachment is operated through a knuckle-joint connection. The taper attachment is located close to the cross-feed screw extension block which receives all strains on the attachment. This attachment is graduated both in taper per foot and degrees, and is provided with a micrometer adjustment. On a motor-driven lathe the motor is supported on a bracket attached to the back of the left-hand leg, thus eliminating the necessity of an idler pulley.

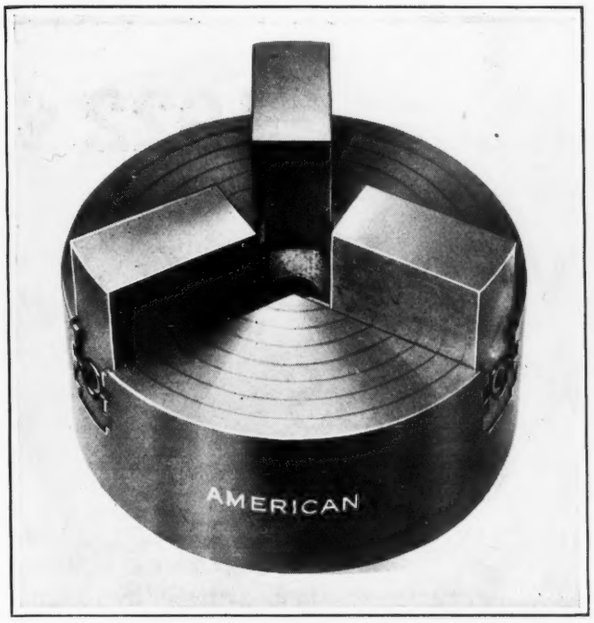
PEDRICK BORING UNIT

In December MACHINERY was published a description of a taper boring-bar placed on the market by the Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia, Pa. Another boring unit somewhat similar in design and which may also be driven by belt, electric motor, air drill or by hand, is here shown applied to large housings for boring the bearings in line with each other. The unit consists of a boring-bar, feeding and driving mechanisms, and the cross-head. The bar is a steel forging having a square-thread feed-screw located in a groove that extends almost the full length of the bar. The bar is 3 inches in diameter by 3 feet long and affords a travel of 18 inches. In the illustration the device is shown provided with an extension for the particular job in hand.

The feed-case is attached to one end of the bar, and by blocking the handwheel, this mechanism will be automatic in operation. Two changes of feeds may be thrown in or out of operation by the movement of a slip-pin. When a larger range of feeds is required, a three-change feed-case may be furnished. It will be seen that the unit is attached to the work by means of the cross-head, which also serves as a guide for the boring-bar. This cross-head is provided with a convenient means of accurately setting the boring-bar for an operation. The latter may also be used in vertical positions.



Boring Large Housings with a Boring Unit made by the Pedrick Tool & Machine Co.



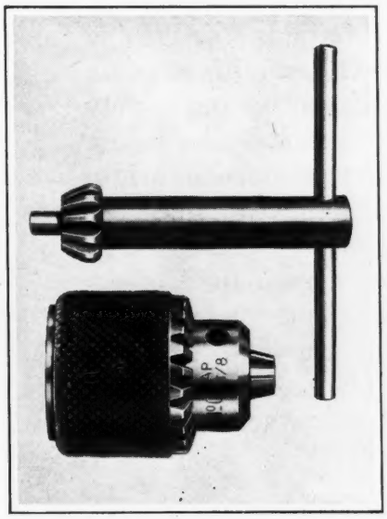
Three-jaw Air-operated Combination Chuck made by the S-P Mfg. Co.

AMERICAN IMPROVED AIR-OPERATED CHUCKS

The line of air-operated chucks formerly manufactured by the American Air Chuck Co. has been redesigned and is now being made by the S-P Mfg. Co., 872 E. 72nd St., Cleveland, Ohio. The capacity of the standard chucks in this improved line ranges from 6½ to 18 inches. The accompanying illustration shows a three-jaw combination chuck designed to hold the work by either internal or external surfaces and intended for general manufacturing purposes. Special jaws or master slides having false jaws can also be furnished for quantity production work. Sector levers operate the chuck slides for the universal movement, these levers being fastened to steel blocks fitted to the rim and center part of the chuck. A patented feature permits shutting off the air from the cylinder without releasing the grip on the work. The chuck can be quickly arranged for use as an ordinary lathe chuck in the event that the supply of air fails.

JACOBS DRILL CHUCK

A small chuck designed for use on watchmakers' lathes and jewelers' drilling machines, and in the multiple drilling, and tapping of work on which the holes have close center distances, has been brought out by the Jacobs Mfg. Co., Hartford, Conn. This chuck is of the same design as the "Super" drill chuck described in MAY MACHINERY, but is intended for holding drills as small as No. 80, which is 0.013 inch in diameter, and for operation at a speed of approximately 20,000 revolutions per minute. The body of the chuck is machined within a tolerance of 0.0005 inch, this degree of accuracy being essential to obtain a correct balance in operation on account of the high speed at which the chuck is employed. The chuck is ⅞ inch outside diameter, 1 5/16 inches maximum over-all length, and weighs about 2 ounces.



Small Chuck made by the Jacobs Mfg. Co.

NEW MACHINERY AND TOOLS NOTES

Nipple-holder: Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn. Two sizes of holders intended for use in making both right- and left-hand nipples. The No. 20 holder is suitable for nipples from ¼ to 1 inch in size, while the No. 30 holder is for nipples ranging in size from 1 to 2 inches.

Bending, Forming, and Shearing Machine: Bussel Machine Co., El Paso, Texas. A hand-operated machine which requires no extra dies to bend any size of stock within its capacity to any angle. The machine will bend right- or left-hand work without adjustment. The bending posts have four bending edges and make less than one-quarter turn in producing a 90-degree angle which is obtained without the use of a square.

Drilling and Tapping Machine: W. Gaterman Mfg. Co., Manitowoc, Wis. A drilling and tapping machine known as the "Electro-magnetic." The tap is held in a floating spindle driven through two coil springs in such a manner that shocks and jars on the tap are eliminated. On the top of the machine is a device which automatically reverses when the torque transmitted to the tap is too great. Electromagnets are employed in the reversing mechanism.

Portable Electric Rivet Heater: U. S. Electric Co., New London, Conn. A portable electric rivet heater built with two, four, or six electrodes for manual operation. The larger sizes can also be furnished with an automatic movement for carrying the rivets between the electrodes and discharging them when heated. In a machine of the latter design, two intermittently rotating members carry the rivets forward in pairs. Cams open and close the electrodes with the movement of the carriers.

Drilling Fixture: Hartman Mfg. Co., 308 Pearl St., Hartford, Conn. A device intended for use on drilling machines to take the place of the many parallel strips and pieces of blocking required when much drilling of irregular shaped pieces is done but where a quantity of any one kind does not warrant making a special jig. The fixture consists primarily of a base block and two adjustable angle-plates that may be placed in any position relative to each other and securely fastened.

Hot-pressed Nut Machine: Acme Machinery Co., Cleveland, Ohio. A machine for making hot-pressed nuts from a bar of special section. In the first operation the bar is indented on both sides to form the sides at angles equal to those of the sides of two abutting nuts. As the indenters withdraw, the blanks are sheared off and carried to the die box, where two punches advance from opposite sides and pass part way through each blank, compressing it in the center so that the surrounding metal flows and fills all parts of the die. The core is finally punched out.

Bolt-cutting and Nut-tapping Machine Operating Device: Key Boiler Equipment Co., 27th St. and McCasland Ave., East St. Louis, Ill. An air-operated automatic device which controls the operation of bolt-cutting and nut-tapping machines. When applied to a bolt-cutting machine, the device clamps the work, feeds it into the dies, opens the dies after the thread has been cut, returns the carriage to its starting position, and sets the dies for the next cut. When applied to a nut-tapping machine, the spindles are held up by an air-operated piston when the taps are full, the rising and falling of the spindles is controlled, and the blanks are automatically fed.

1833 1922

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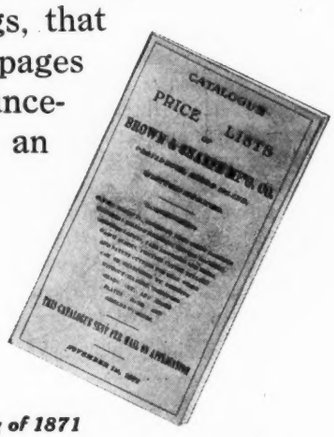

Sixteen page Catalog of 1871

General Catalog No. 137. The 1922 Buyer's Guide for Mechanical Equipment

The demand for products of uniformly high quality has so increased that today, in 1922, the General Catalog describing Brown & Sharpe Products contains over six hundred pages and lists a quantity and variety of equipment unthought of in the earlier years. 1922 marks the eighty-ninth year since the origin of the business and the fiftieth year since the moving of our plant to its present location. Our customers have the benefit of a rare fund of accumulated knowledge and experience which is reflected in the design and manufacture of our products and is at the disposal of customers seeking practical solutions of their mechanical and manufacturing difficulties.

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BROWN & SHARPE MFG. CO.

PROVIDENCE, R.I., U.S.A.

The Industrial Machinery Division of the Department of Commerce

THE reorganization of the Department of Commerce, which was taken in hand by Mr. Hoover when he became Secretary of the Department, has now proceeded to a point where the various bureaus and divisions are actually engaged in the work for which each one was created. The division to which the machine tool industry belongs is known as the Industrial Machinery Division. According to the 1919 census, there are more than 4000 factories in the United States producing industrial machinery, the value of these factories exceeding $2,200,000,000 a year. These 4000 factories have more than 400,000 employes in normal times, providing a support for probably 1,500,000 people. Seventeen per cent of the products of these factories, or nearly $400,000,000 a year is exported, and it is evident that an export business of such a volume is of great importance both to the owners and the employes of the factories employed in making industrial machinery.

The Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce was developed in order to promote the export trade of the machine-building industries, and it is believed that the foreign trade in this field can be materially increased by the work that will be done by the Bureau under Mr. Hoover's leadership. W. H. Rastall, chief of the Industrial Machinery Division, believes that while present export figures equal approximately an export of $1000 a year per employe, this figure can be doubled by the application of American salesmanship and good business methods, aided by the Government through a properly organized and conducted Department of Commerce. The work of the Machinery Division will be directed toward this end.

Purpose and Aim of the Industrial Machinery Division

The Industrial Machinery Division covers, in addition to machine tools and metal-working machinery, mining machinery; paper and pulp mill machinery; pumps; printing presses; refrigerating machinery; shoe machinery; sugar mill and saw mill machinery; woodworking machinery; textile machinery; typesetting machinery; road-making machinery; air compressors; concrete mixers; engines and railway cars; excavating machinery; laundry machinery; flour mill machinery; gas and water meters; and elevators. Briefly described, it may be said to include every kind of machinery used in factories, power plants, mines, railways, and engineering construction work, but it does not take in agricultural and farm machinery, or electrical machinery or equipment. The Division of Industrial Machinery has been placed in the hands of qualified engineers, who have actually sold a great variety of machinery in different parts of the world, and who are therefore familiar with conditions existing abroad. They are experienced exporters of American machinery, and have faced world-wide competition in foreign markets.

The Division is anxious to have American manufacturers in the machinery field realize that it aims to be of the greatest possible service to them, and feels that the best way to accomplish this is by establishing close contact with the industries. There are 600 representatives of the Government in foreign countries who can be called upon to obtain specific trade information when required, and should circumstances justify, arrangements can be made to send special investigators into the foreign trade fields. No problem is too large or too small for this service. As an indication of what the Department of Commerce actually accomplishes, it may be mentioned that the Department as a whole answers more than 1000 inquiries daily, or approximately 350,000 a year.

Services Offered by the Industrial Machinery Division

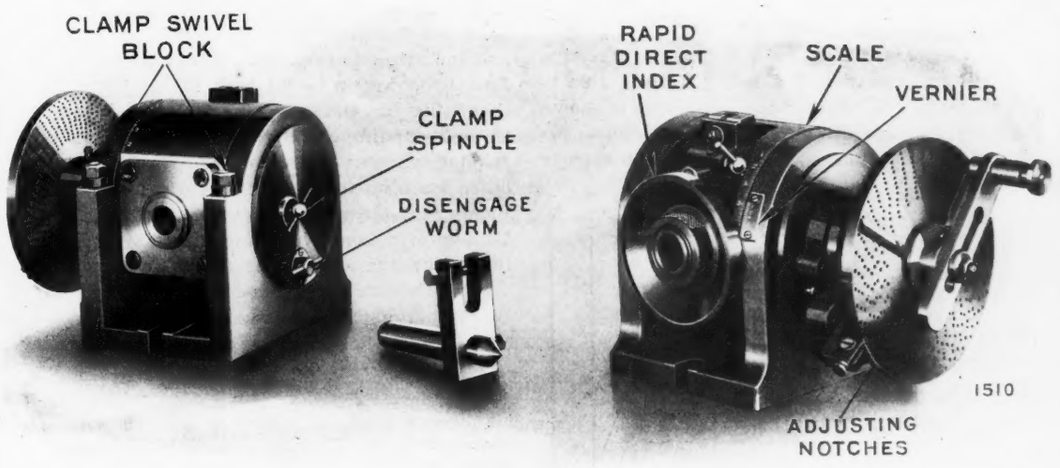
The men in charge of the Industrial Machinery Division are familiar with the different sales methods used in the various markets of the world in marketing machinery. Where it is wisest to sell through agents or dealers, the Division has reasonably complete lists of available dealers which will be furnished to manufacturers who are interested. When the manufacturer is able to visit Washington, he can also obtain much additional information relating to these dealers, which has been collected by the Bureau from time to time, to make it possible to select suitable agents for any specific product.

Through its overseas' representatives the Government is now receiving information relating to new engineering enterprises. Manufacturers who wish to obtain such information quickly should communicate with the Industrial Machinery Division so as to be placed on its list for this kind of information. The Division is also making studies of the various foreign markets and export problems, and these studies are published in Commerce Reports, the newspapers, and the trade press, according to circumstances. A report on the machinery markets of Asia is now being prepared, which is the result of a special investigation made by Mr. Rastall personally, who visited every important city between Yokohama and Bombay, thirty months having been spent in this investigation. The Division is also in a position to answer questions relating to foreign tariffs, patents, trademarks, agency agreements, and legal matters, through the cooperation of the Commercial Law Division and the Foreign Tariffs Division. The Bureau of Foreign and Domestic Commerce has frequently been able to assist in adjusting disputes, and, if necessary, the cooperation of the Department of State may be obtained through the Bureau.

Present Work of the Division of Industrial Machinery

One of the present activities of the Industrial Machinery Division is to collect the laws and regulations of all foreign countries covering the inspection, construction, and operation of steam boilers and air- and gas-containers. These will be available to American manufacturers and exporters of machinery. A general survey of the railway mileage and rolling stock all over the world is in preparation. A collection of the electrical regulations covering the whole world will be made.

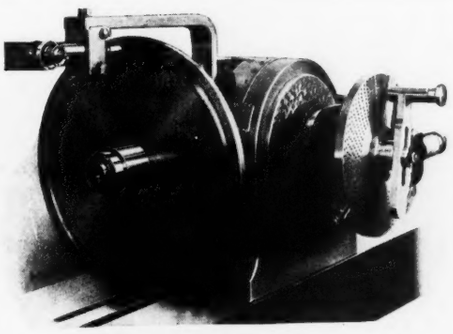
Briefly, it is the object of the Department of Commerce, through the Industrial Machinery Division, to collect any information that American manufacturers deem necessary for extending their foreign trade. The cooperation of the industries is requested as regards suggestions for the extension of the work of the Department. In making plans for the future work of the Industrial Machinery Division, advice from manufacturers is needed. The Division wishes to aid manufacturers in securing actual sales in the widely distributed markets of the world, and welcomes advice and suggestions from manufacturers in preparing its plans. Furthermore, the Department of Commerce invites manufacturers to use the information stored up in the Department to the fullest extent, and to present any problem relating to foreign commerce to the Department.



Cincinnati Tool-room Millers

When you talk about the Tool-room Miller, you think first of the Dividing Head. This is a feature that you depend most upon. You want it to be accurate and reliable. We believe we can show you that CINCINNATI UNIVERSALS, both MILLERS and DIVIDING HEADS, come closest to meeting your requirements.

There is not space to give details here. Ask for them.

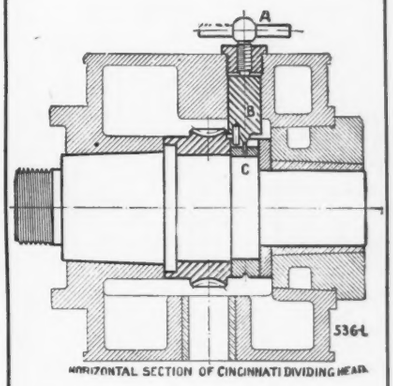


The Indexing Test

The 12 in. disk contains an accurately graduated silver ring. By means of a microscope with a micrometer adjustment, we can read the errors in the wormwheel and also those in the worm to one-fortieth of a thousandth (.000025) of an inch; not only the errors in pitch, but also the inaccuracies of the tooth face.

The maximum indexing error allowed is .001 in. in 12 in.

Let Us Send You the Catalog



The spindle clamp consists of a split ring, C, which is spread by the wedge B by tightening the screw A, thus clamping the spindle endwise, securely, without crowding it out of alignment.

The Cincinnati Milling Machine Co.

CINCINNATI, OHIO, U. S. A.

BRITISH MACHINE TOOL EXPORTS AND IMPORTS

In a review prepared by W. H. Rastall, chief of the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce, at Washington, some very interesting figures and charts are presented that will prove of value to all engaged in the export of machine tools. A chart is shown in Fig. 1, illustrating comparative British and American exports of metal-working machinery, as well as German exports

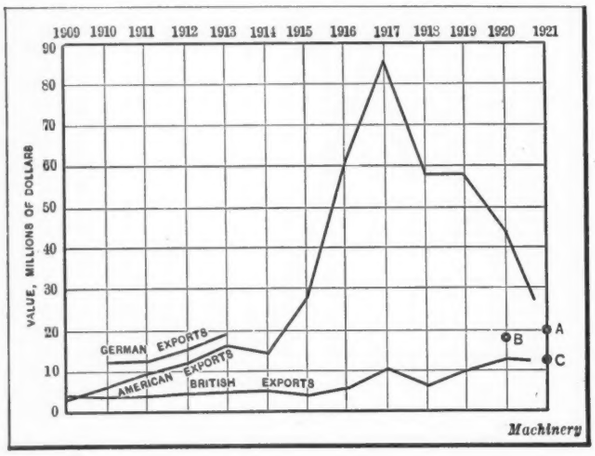


Fig. 1. Exports of Metal-working Machinery since 1909 by the United States, Germany, and Great Britain

for the years 1910, 1911, and 1912. It will be noted that, while in the four years preceding the war American exports increased rapidly, the exports of Great Britain made but little progress. During the war period American exports increased in an unprecedented manner, but show a rapid falling off in 1920 and 1921, while the British exports at the end of 1920 reached a higher level than they had ever attained before. The line representing German exports in pre-war years is somewhat deceptive, because the classification employed by the German customs authorities includes a great deal of metal-working machinery and tools not included in the British and American returns. The estimated exports of America for 1921 are denoted by circle *A;* those

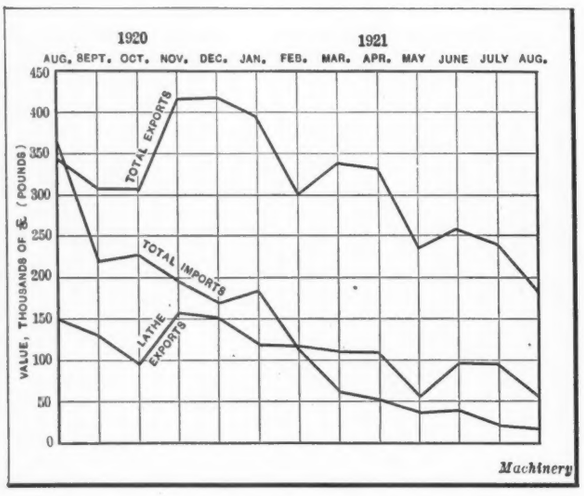


Fig. 2. British Exports and Imports of Machine Tools from August, 1920 to August, 1921

of Germany for 1920, by circle *B;* and those of Great Britain for 1921, by circle *C*.

The diagram Fig. 2 shows details of recent British exports and imports prepared from data published by MACHINERY, London. This chart shows that at the present time the British exports are falling off, though not in as marked degree as the imports. The chart also contains a line for exports of lathes from Great Britain, showing that the general tendency in regard to decreased exports is practically followed by the decreased exports in this type of machine tool. Complete details showing the exports of machine tools from Great Britain for each month beginning August, 1920, and including August, 1921, have also been compiled by Mr. Rastall, giving in detail both the number of machines and the value for the following groups: Lathes, drilling machines, grinding machines, milling machines, planing and shaping machines, punching and shearing machines, and all other machine tools. The imports of machines into Great Britain for the same classes of machines are also covered. This information may be obtained by individual manufacturers through application to the Industrial Machinery Division, Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C.

* * *

PERSONALS

CHARLES ADDAMS, formerly a sales engineer with the Standard Roller Bearing Co., Philadelphia, Pa., is now connected with the Bearings Co. of America as sales engineer in the eastern territory.

J. M. MCNEAL, sales engineer of the Landis Machine Co., Inc., Waynesboro, Pa., manufacturer of bolt and pipe threading machines, has returned to this country after spending a year and three months traveling in England and on the Continent.

C. F. MEYER, assistant secretary of the Landis Machine Co., Waynesboro, Pa., manufacturer of bolt and pipe threading machines, has recently returned from a year's trip around the world, having visited India, Java, China, Japan, and the Hawaii Islands.

JAMES HARTNESS, president of the Jones & Lamson Machine Co., Springfield, Vt., and governor of the state of Vermont, has been awarded the Edward Longstreth medal by the Franklin Institute, acting through its Committee on Science and the Arts, for the development of the Hartness screw thread comparator.

WILLIAM S. DICKSON has been appointed assistant manager of the Crane Machinery Co., Buffalo, N. Y. Mr. Dickson was identified for many years with the Cincinnati Planer Co. Later he became sales engineer of the Acme Machine Tool Co. and general manager of the Greaves-Klusman Tool Co. During the last two years he has been connected with the Cleveland office of W. K. Stamets.

EARL B. STONE has been appointed advertising manager of the Cleveland Tractor Co., Cleveland, Ohio, to take the place of G. B. Sharpe, who has resigned. Mr. Stone has been connected with the company for two and a half years, serving as sales representative, assistant advertising manager, and district sales manager. His former advertising experience included work with the General Fireproofing Co., Youngstown, Ohio, and the National Acme Co., Cleveland.

MARTIN G. SPERZEL has been made sales manager of the Royersford Foundry & Machine Co., Royersford, Pa., succeeding John D. Sells, who is retiring from active business. Mr. Sperzel has been connected with the company for the last six years as sales engineer, and was connected with the Standard Roller Bearing Co. for almost the same length of time. The Royersford Foundry & Machine Co. will continue to make and market the Sells roller bearings, which it has done since the latter part of 1904, when Mr. Sells became identified with the company.

HJALMAR G. CARLSON, of Worcester, Mass., was awarded a gold medal—the annual prize of the American Society of Mechanical Engineers—December 7, at the meeting of the society in New York. The medal is awarded to the engineer who is responsible for the most noteworthy development in mechanical engineering practice that has been called to the attention of the society during the past year. Mr. Carlson won the prize for the work that he did in connection with a process for the production of 30,000,000 drawn steel booster casings used as component parts in high-explosive shells. The method developed is not one confined to the production of war material, but may also be applied to drawn steel parts for industrial purposes in general. In awarding the prize, it was stated that Mr. Carlson's invention, according to the Army Ordnance Department, was of the greatest importance during the war, in enabling the military authorities to secure adequate artillery ammunition for the American Expeditionary Forces.

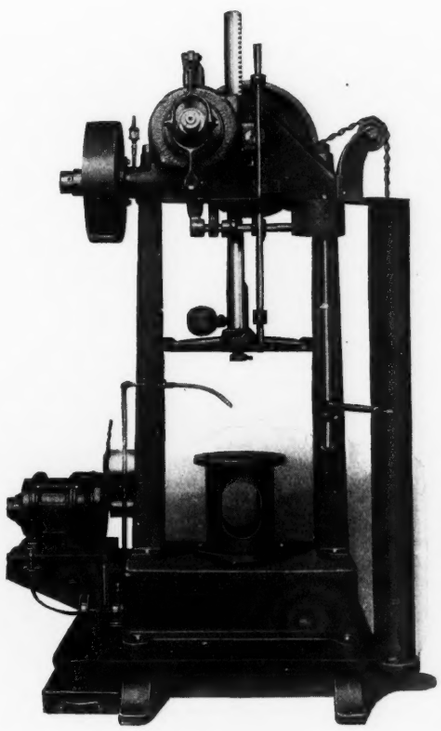
ANNOUNCEMENT

SOMETHING NEW

Yet tested and tried

The Lucas Vertical Push-Broaching Machine

(A modification of the Lucas Power Forcing Press)

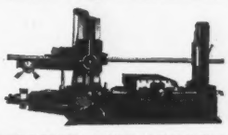


Has been in successful operation for over two years on *vertical push-broaching* and *production assembling.*

ADVANTAGES:

Shorter, and therefore less expensive broaches.
Better lubrication of cutting edges.
Easier setting of work, easier manipulation of broaches.
More production.
A choice of fixed positions for the operator.
Lever Control (adjustable for height).
Less Floor Space Required.

WE ALSO MAKE THE
"PRECISION"



BORING, DRILLING AND MILLING MACHINE

Send for Special Circular C-26-M.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Aux Forges de Vulcain, Paris. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

NEW BOOK ON SHOP MATHEMATICS

SHOP ARITHMETIC FOR THE MACHINIST. By Erik Oberg. 116 pages, 6 by 9 inches; 92 illustrations. Published by THE INDUSTRIAL PRESS, 140-148 Lafayette St., New York City. Price, $1.

This treatise is intended for men in machine shops and tool-rooms whose training has been chiefly along practical lines, and also for students of mechanical subjects who desire a book featuring the problems commonly encountered in shop work. All subjects have been treated as simply as possible, and many examples are used to show exactly how different arithmetical processes are applied to practical shop problems. The advantages and use of formulas are explained, and most of the formulas are written out or expressed in words to show the student just what each formula actually means. In fact, a special effort has been made to explain all methods in plain, simple language.

Many text-books deal with principles rather than with specific examples, but the shop man not used to solving problems often finds it difficult to apply these principles. The purpose of this treatise, therefore, is to present the most common machine shop and tool-room problems and show clearly, by carefully selected examples, how the principles are applied in each case. It is assumed that the student understands such elementary subjects as addition, subtraction, multiplication, and division of whole numbers and fractions, and that he is familiar with the use of common mathematical signs for indicating the different operations referred to. If the student is not entirely familiar with the elementary arithmethical processes mentioned, it is advisable for him to study a text-book on arithmetic before attempting the solution of the problems given.

COMING EVENTS

January 11-14—Annual meeting of the Society of Automotive Engineers in New York City. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

April 19-20—Annual meeting of the National Metal Trades Association in New York City; headquarters, Hotel Astor. Secretary, Homer D. Sayre, Peoples' Gas Bldg., Chicago, Ill.

April 24-29—Annual convention and exhibit of the American Foundrymen's Association in Cleveland, Ohio; headquarters, Cleveland Public Hall, Lakeside Ave. and E. 9th St. Secretary, C. E. Hoyt, 140 S. Dearborn St., Chicago, Ill.

May 8-11—Spring meeting of the American Society of Mechanical Engineers in Atlanta, Ga. Assistant Secretary (Meetings), C. E. Davies, 29 W. 39th St., New York City.

NEW BOOKS AND PAMPHLETS

Ninth Annual Report of the Secretary of Commerce Covering the Fiscal Year Ended June 30, 1921. 149 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C.

Results of Some Tests of Manila Rope. By Ambrose H. Stang and Lory R. Strickenberg. 11 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 198 of the Bureau of Standards. Price, 5 cents.

A Course in Mechanical Drawing. By Louis Rouillion. 92 pages, 8 by 6½ inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $1.50.

The fifteenth edition of this book has now been issued in revised and enlarged form. It explains the art of making working drawings, lettering, and dimensioning, and is intended either for school use or for self-instruction. This course was originally issued in blueprint form with accompanying typewritten notes, and has been in use at the Pratt Institute and Y. M. C. A. classes for a number of years. The course covers a period of two school years of about twenty-four weeks each. Because of the interest in isometric drawing evinced by students, this subject has been added to the present edition. A parallel course, in the form of supplementary exercises, is presented at the end, so that the book may be used as a text-book in class work.

Railroad Shop Practice. By Frank A. Stanley. 331 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $4.

This book deals with shop practice in railroad repair shops, including large, medium and small shops, and describes typical methods and appliances adapted to the class of work handled in these shops. The material in the book is presented in twenty-three chapters. An idea of the operations dealt with will be obtained from the following list of chapter heads: The Work of the Railroad Repair Shop; Operations on Locomotive Cylinders; Machining Pistons and Piston-rings; Piston Valves, Cages and Rings; Tools for Crossheads and Guides; Connecting-rod Operations; Making Driving-boxes; Machining Shoes and Wedges; Eccentrics, Links, and Tumbling Shafts; Locomotive Frame Work; Driving Wheels and Axles; Wheel Shop Equipment and Methods; Machining Pipe Joints and Other Parts; Brass Tools for Locomotive Valves and Fittings; Some Portable Tools and Appliances; Special Tools, Cutters and Tool-room Methods; Air Pump, Hose Coupling, and Miscellaneous Devices; Blacksmith Shop Equipment and Work; Boiler Shop and Flue Work; Tools and Methods Used on Steel Car Work; Welding Operations on Locomotives and Cars; Reclamation Work; and Handling Materials in the Railroad Plant.

Hendrick's Commercial Register of the United States. 2324 pages, 8½ by 11½ inches. Published by the S. E. Hendricks Co., Inc., 70 Fifth Ave., New York City. Price, $12.50.

This is the thirtieth annual edition of this well-known commercial register of producers, manufacturers, dealers, and consumers. The new edition appears in a slightly larger size, with a type face of 7 by 10 inches. The text matter has been opened up, leaving a space between columns, thus making it more readable and giving ample space for checking and memoranda. The larger page, taking more matter, naturally makes a smaller book, which is easier to handle. Although the increased size of the page takes 25 per cent more matter and would normally reduce the number of pages from 2800 to 2100, new matter has been added to make more than 2300 pages. The book covers the engineering, machinery, electrical, building, chemical, hardware, iron and steel, mining, quarrying, railroad, architectural, constructional, contracting, mill, and kindred industries throughout the United States. It contains over 100,000 names of individuals and firms, comprehensively classified by trades or products and thoroughly indexed and cross-indexed. The first and main section of the book is the classified trades section, covering 1552 pages, in which are classified alphabetically all the trades in the various fields mentioned. There are over 3000 classifications in the mechanical industries which include the names and addresses of the manufacturers of practically every kind of machine and operating supply used in the production of raw materials and in the manufacture of finished and semi-finished products. A special list of over 15,000 machine shops and foundries, classified according to the exact type of work done, is included. The second section contains a list of trade names or special brands of the products included in the classified directory, and covers 190 pages. This is followed by the alphabetical section, including 403 pages, in which are given the names and addresses of all manufacturers in the fields covered, as well as the main industry of each firm. The address of the head office or works only is given, the branch office and work addresses being included in the various classified lists. A complete index to the trade classifications is included, which covers 132 pages.

NEW CATALOGUES AND CIRCULARS

Lovejoy Tool Works, Chicago, Ill. Circular illustrating the Lovejoy No. 3 portable electric drill with a capacity for drilling ¼ inch in steel.

Atlas Vise Co., Inc., Lowville, N. Y. Circular containing illustrations and specifications covering the line of "Nutyp" vises for machinists and pipe fitters.

Gas Producer & Engineering Corporation of New Jersey, 115 Broad St., New York City. Leaflet containing a list of representative users of "Galusha" gas generators.

Turner Machine Co., Danbury, Conn. Circular showing typical examples of Turner spur and bevel cut steel gears. This company makes a specialty of replacement gears for Ford cars.

New Departure Mfg. Co., Bristol, Conn. Loose-leaf sheets Nos. 141 and 142FE, illustrating and describing the application of New Departure ball bearings in portable electric drills and pneumatic corner drills.

Jones Machine Tool Works, Philadelphia, Pa. Circular containing illustrations and dimensions of the Jones motor-driven slotting machines, which are made in five sizes of 12, 16, 20, 25, and 32 inches, respectively.

Monitor Controller Co., Baltimore, Md. Circular illustrating an installation of the Monitor system of controllers operating diamond polishing machines, which require a positive drive, free from vibration and fluctuation.

Pratt & Whitney Co., Hartford, Conn. Circular 269, describing the distinctive features and details of construction of P & W vertical shapers, which are made in 6- and 10-inch sizes, for tool-room work on a production basis.

Brown & Sharpe Mfg. Co., Providence, R. I. Leaflet containing a chart showing the growth of the Brown & Sharpe plant from 1872, when it included 55,000 square feet of floor space, to its present size of 1,471,400 square feet.

Universal Boring Machine Co., Hudson, Mass. Circular illustrating and describing the Universal horizontal boring machine made by this concern, which is equipped with a boring-bar 4½ inches in diameter for performing heavy work, such as is done in railroad shops.

American Spiral Pipe Works, Chicago, Ill. Circular showing installations of American spiral-riveted pressure pipe, lap-welded steel pipe, and corrugated boiler furnaces. Examples of special fittings and forged steel pipe flanges are also illustrated.

Pawling & Harnischfeger Co., 38th and National Aves., Milwaukee, Wis. Bulletin 4F, describing the details of construction of the P & H No. 4F horizontal, boring, milling and drilling machine of the floor type, which is designed to drive high-speed tool steels to capacity limits.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., is distributing small vest-pocket blotters (No. 57), illustrating the Westinghouse Type LC crane safety switches. A larger size blotter, No. 56, telling how to insure against loss by stocking renewal parts, is also being distributed.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 105-A, descriptive of Hisey "Super" universal motor drills, designed for operation on direct current or single-phase alternating current, for any frequency from 25 to 60 cycles. These drills may be used for drilling in either wood or metal.

Triplex Machine Tool Corporation, 18 E. 41st St., New York City. Catalogue 1, illustrating the uses of the Triplex No. 1 combination bench machine tool for turning and boring; horizontal, angular, and vertical milling; thread cutting; and drilling. Specifications of the machine are included.

United States Blueprint Paper Co., 201 S. Wabash Ave., Chicago, Ill. Circulars descriptive of several drafting instruments, including the "Draftsquare" for use in drawing nuts, circumferences, radii, screw threads, and for lettering; the Ames lettering instrument; and sets of drawing instruments.

Harrisburg Corporation, Harrisburg, Pa. Bulletin A, containing an illustrated description of the Rainsford type of radial drilling machine made by this concern. These machines are made in seven sizes, with capacities for drilling to the center of circles 7, 8, 10, 10, 12, 14, and 16 feet in diameter, respectively.

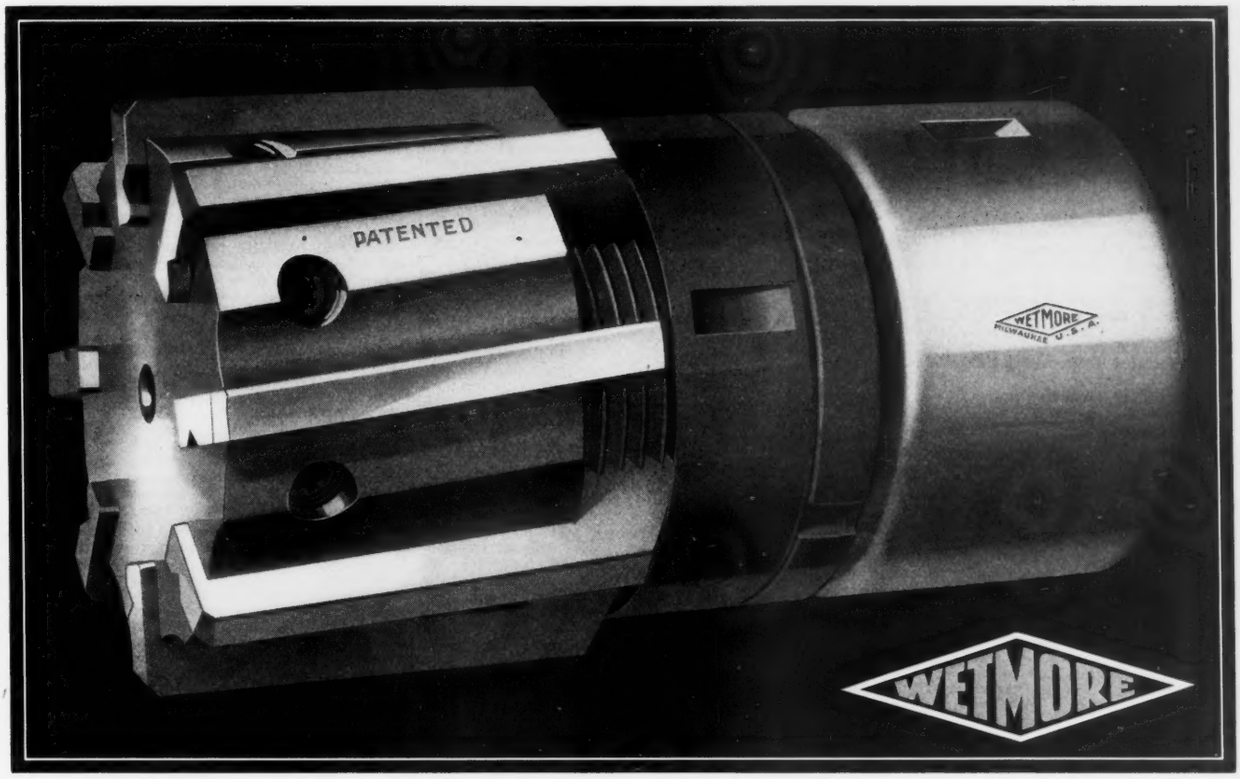
Pangborn Corporation, Hagerstown, Md. Pamphlet giving data on the Pangborn Type GF industrial barrel sand-blast intended for the manufacturing plant, small foundry, or shop doing small work in limited volume. The company is also distributing a blotter illustrating the Type DC sand dryer and the Type HC moisture and oil separator.

Ingersoll Milling Machine Co., Rockford, Ill. Circular showing examples of standard Ingersoll inserted-tooth milling cutters, which are adapted for face-milling steel, aluminum, or cast iron. This line of cutters also includes arbor mills, solid mills, and special inserted-tooth profile cutters. The field of application of the types illustrated is outlined.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Folder 4474, treating of lead-base babbitt metal for use in motor and generator bearings. This metal, which has been used for years in the motors made by this company, has just been placed on the market. The pamphlet contains instructions for using this metal so as to obtain the best results.

Howe Chain Co., Muskegon, Mich. New 100-page catalogue No. 121, illustrating and describing the Howe complete line of chains for elevating, conveying, and power transmission. The catalogue contains full-size illustrations, complete information and data, and price lists for all standard chains. Copies of the book will be sent to those interested upon request.

Eck Dynamo & Motor Co., Bellville, N. J. Bulletins 1300, 1500, 1600, and 1900, descriptive of Eck direct-current motors, vertical motors, back-geared motors, and Types I and I-B induction motors, respectively. Each of the bulletins gives complete specifications for the different sizes of motors, in addition to a general description covering the features of construction.



Announcing

The New Wetmore "Bull-dog"

Combining all the advantages of both solid and adjustable reamers, this new Wetmore Expanding Heavy-duty Reamer (6, 8 or 10 blades) represents the highest development of quantity-production precision tools.

No huskier or more enduring reamer has ever been produced for heavy duty work than this Wetmore "Bull-dog". The body is *guaranteed* against breakage, even under severest reaming tests. Its new tongue drive relieves the strain on the coupling nut. Assures perfect alignment between arbor and body. Large adjustment provides for wear and regrinding, so that the "Bull-dog" with its original blades will outlast several solid, non-adjustable reamers.

In every detail—design, quality of materials, workmanship, finish—the "Bull-dog" is typical of Wetmore standards of manufacturing. And the more carefully you compare it with other good reamers, the more you will appreciate these advantages of Wetmore Expanding Reamers:

Left-Hand Angle Cutting Blades that prevent digging in, chattering, and scoring of the reamer while backing out.

Solid, heat-treated alloy steel body—guaranteed against breakage.

Adjustments to the thousandth of an inch can be made in less than a minute. In fact, the Wetmore is the quickest and easiest adjusting reamer made. Cone expansion nut keeps blades always parallel with axis.

No grinding arbor required for regrinding. Wetmore Reamers can be reground on their original centers.

The above are but a few of many features of Wetmore Expanding Reamers. Let us send you our 1922 Catalog—just off the press. No better "hand-book" on reamers was ever published, we believe. Write for *your* copy.

WETMORE REAMER COMPANY., Milwaukee, Wisconsin

(Manufacturers of Expanding Reamers and Cylinder Reaming Sets, Arbors and Thread Gauges)

WETMORE REAMERS

EXPANDING

G. A. Gray Co., Cincinnati, Ohio. Catalogue 37, containing a detailed description and illustrations of Gray planers, which are made in three types known as standard planers, maximum service planers and switch and frog planers, and in a variety of sizes. The various details of construction are made clear by a liberal use of illustrations in connection with the text.

Gould & Eberhardt, Newark, N. J. Bulletin 90, containing a description of a new system of automatically hobbing worms, utilizing a hob which has a broaching action and is so designed that worms having shoulders at both ends may be cut. These hobbing machines will cut either single or multiple threaded worms. Copies of the pamphlet will be sent to those interested upon request.

American Bronze Corporation, Berwyn, Pa. Engineering data sheets 107, 108, 109, 110, 111, 112, containing data on running clearances allowed for different classes of bearings; permissible angular deflection of journals in plain bearings, with chart; relation of rubbing speeds to revolutions per minute; allowances for press fits of hard bronze bushings; and design of water pump for automotive engines.

Eclipse Interchangeable Counterbore Co., 7410 St. Aubin Ave., Detroit, Mich. Circular D, containing data covering Eclipse "Junior" interchangeable spot-facers, which are so made that many different sizes may be used with each holder, the tool being made of high-speed steel and the holder of nickel steel. Adapters are provided for these tools so that they can be used with standard Eclipse holders and standard pilots.

Hadfield-Penfield Steel Co., Bucyrus, Ohio. Catalogues descriptive of this company's Diesel type horizontal and vertical standard fuel oil engines, which are built on the two-cycle principle. The horizontal engine is made in three sizes of 50, 75, and 100 brake horsepower, the latter two sizes being built as twin units giving 150 and 200 brake horsepower. The vertical engine is built in two- to six-cylinder units, developing 50 and 125 brake horsepower per cylinder.

Electric Furnace Co., Alliance, Ohio. Folder showing a large number of typical installations of Bailey electric furnaces in the eastern states, Pennsylvania region, Ohio, Ohio valley, Michigan, Middle West, and Canada. The furnaces selected as examples are those that handle a wide range of non-ferrous alloys and a diversity of brass products, and the illustrations show the various sizes that have been built to meet the needs of different melters of non-ferrous metals.

W. S. Rockwell Co., 50 Church St., New York City. Bulletin 240, entitled "Heat-treatment of Springs with Stationary and Continuous Furnaces," containing an outline of the fundamental principles of heating and handling, with illustrations of their practical application in the manufacture of a wide variety of springs. This pamphlet is not merely a furnace catalogue, but contains general information which should be of interest to those engaged in this class of work.

Ingersoll-Rand Co., 11 Broadway, New York City. Pamphlet containing a reprint of a paper entitled "Steam Condensing Plants," by Paul Bancel, read before the Baltimore Section of the American Society of Mechanical Engineers. This paper presents a study of power plant conditions and discusses new phases of the fixed and operating charges of power plant equipment. A new Ingersoll-Rand surface condenser is described in the article, as well as the barometric and low-level, multi-jet types made by this company.

Seifreat-Woodruff Co., 20 S. Canal St., Dayton, Ohio. Circular announcing an industrial exhibit of machine tools in operation which was shown at the company's Dayton show-rooms in December. Among the tools exhibited were an American Tool Works Co.'s lathe, shaper, and radial drilling machine; Barnes drilling machine; Colburn manufacturing drilling machine; Gooley & Edlund manufacturing milling machine; LeBlond universal milling machine and universal cutter grinder; Libby turret lathe; Lumsden tool grinder; Springfield Machine Tool Co.'s lathe and straightening press; and Wood turret screw machine.

Fafnir Bearing Co., New Britain, Conn. Catalogue 21, of Fafnir ball bearings. The first section of the book contains descriptive material on types of Fafnir ball bearings and how to mount them; cleanliness and lubrication; types of closures; cross-sections of mountings; and Fafnir double ball bearing hanger boxes and transmission ball bearings. The construction is made clear by a liberal use of both halftone and line illustrations. The second part contains tables of sizes, dimensions, load ratings and prices of Fafnir ball bearings, as well as tables of standard fits for ball bearing mountings, and decimal equivalent tables.

American Broach & Machine Co., Ann Arbor, Mich., has published a broach handbook which has been compiled for the purpose of placing information on broaching, broached fittings, and the use and care of standard broaches before engineers, superintendents, draftsmen, purchasing agents, and others who come in contact with broaching operations. The first few pages are devoted to S A E broached fittings. In the following pages are discussed the method of setting up, grinding, care and use of keyway broaches, round broaches, square broaches and spline broaches. A number of illustrations are included showing interesting broaching operations. The last part of the book contains illustrations and specifications of American rack-operated broaching machines.

National Tube Co., Pittsburg, Pa. National Bulletin No. 17B, containing detailed information on the mechanical uses of Shelby seamless steel tubing. The material is divided into seven subjects as follows: Properties and general characteristics of Shelby steel tubing; use of tubing in place of solid stock or forgings; advantages of tubing in mechanical services; special operations on mechanical tubing; forming and machining mechanical tubing; mechanical tubing for specific purposes; and a survey of the uses of mechanical tubing. The section dealing with special operations on mechanical tubing contains a large number of line illustrations showing examples of parts for which seamless tubing is especially suitable. An idea of the wide application of this product will be obtained by referring to the alphabetical list of applications of seamless steel tubing.

Hunter Saw & Machine Co., Pittsburg, Pa. Catalogue E, illustrating and describing the Hunter complete line of solid and inserted-tooth metal-cutting circular saw blades, inserted-tooth setting device, serrating device for friction disks, slate saws, pipe cutters, circular knives, rotary shear blades, saw sharpening machines, pneumatic hammer rivet sets, chisel blanks, and hardened steel specialties. Tabulated matter giving sizes and prices for each of the products is included. One of the sections of the book contains instructions for the care and operation of Hunter inserted-tooth saws, and the heavy work which can be handled with these saws will be understood by reference to the illustrations. The book concludes with a section of useful information, containing milling saw specifications for different types of machines, tables of number of teeth in milling saws for a given diameter and pitch, approximate weights of circular blades, etc.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Catalogue illustrating and describing the LeBlond line of heavy-duty milling machines. The catalogue contains 111 pages, 8½ by 11 inches, and gives a detailed description of the construction of the cone type and geared drive milling machines. Specifications are given for the different sizes in both types. This line of machines is made in both plain and universal styles, and attention is called to the fact that there has been a complete regrouping and rearrangement of sizes and ranges, the heavy-duty machines having been made considerably heavier and supplemented by a lighter line. The section on dividing heads and milling attachments for LeBlond milling machines includes tables for spacing on plain dividing heads and on LeBlond dividing heads, as well as tables for cutting spirals. The book concludes with instructions for oiling, adjusting, and setting up these machines.

TRADE NOTES

Eastman & Co., 63 E. Adams St., Chicago, Ill., has been organized by D. T. Eastman, formerly advertising manager of the Eagle Picher Lead Co. of Chicago, to engage in technical advertising.

Rich Tool Co., 513 A, Railway Exchange, Chicago, Ill., manufacturer of drills, reamers, etc., has appointed the Busch Corporation of St. Louis representative of the company in the St. Louis territory.

Ford Chain Block Co., Second and Diamond Sts., Philadelphia, Pa., has opened a branch office and warehouse at 85 Walker St., New York City, where a complete stock of chain blocks and trolleys will be carried.

Pennant Tool & Engineering Co., Springfield, Ohio, is now located in its new building at North and Isabella Sts. The company handles tool and die work and special machine work. H. H. Swope is president and general manager.

Rockford Milling Machine Co., Rockford, Ill., has appointed the Charles A. Strelinger Co. of Canada, Ltd., Windsor, Ontario, Canada, exclusive distributor for its products. The products of the Rockford Tool Co. will also be handled exclusively by this company.

Harrold Tool & Forge Co., Columbiana, Ohio, manufacturer of mechanics' hand tools, screwdrivers, and drop-forgings, has recently changed its corporate name to the **Colonial Tool & Forge** Co. Wiebusch & Hilger, Ltd., of New York City, will continue to be the selling representative of the company.

Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City, has moved its Philadelphia office from the Lincoln Building, to larger and better quarters in the Pennsylvania Building at 15th and Chestnut Sts., occupying rooms 905 and 906. This concern also moved its Boston office on December 1 from 10 High St. to the Textile Building at 99 Chauncey St., rooms 802 and 803.

J. B. Engineering Sales Co., Hartford, Conn., has recently moved from 60 Prospect Ave. into larger quarters at 54 Church St. The company specializes in power plant equipment, and is a distributor for Sells roller bearings and other products of the Royersford Foundry & Machine Co., as well as for the products of the Griscom-Russell Co., and the Conveyor Corporation of America.

Rivett Lathe & Grinder Co., Brighton District, Boston, Mass., has recently opened a sales office in Detroit, Mich. The new office is located with the Reed-Prentice Co., at 408 Kerr Bldg. It is requested that prospective purchasers of Rivett machinery in the Detroit district communicate with the Detroit sales office, as facilities have been provided for furnishing information promptly and for filling orders with dispatch.

Greenfield Tap & Die Corporation, Greenfield, Mass., announces that it has consolidated the small tool and drill divisions of the company, and has placed P. T. Irvin, former manager of the drill diyision, in charge of the consolidation, which will be called the small tool division. Mr. Irvin has had considerable experience along these lines, having been sales manager of the Lincoln Twist Drill Co., Taunton, Mass., for the last three years, and prior to that sales manager of the Wells Bros. Co. of Greenfield.

Cincinnati Shaper Co., Elam St. and Garrard Ave., Cincinnati, Ohio, and its subsidiary the **Cincinnnati Gear Cutting Machine Co.** have arranged to open a branch sales office at 940 Lemcke Annex, Indianapolis, Ind. T. C. McDonald has been appointed local manager. This office will supervise the sale of machine tools for these companies in the Indianapolis and Louisville district, as well as in certain states in the southwest. Mr. McDonald will also continue as local representative of the Reed-Prentice Co.

Leonard Machine Works, Philadelphia, Pa., moved on January 1 to their new plant, Baltimore Ave. and Hirst St., Lansdowne, Pa. The new plant was built according to plans made by Mr. Leonard. It is a one-story building, of steel framework and brick construction, with all-steel sash and a monitor roof. The manufacturing floor space is approximately 50 by 100 feet. The company will continue its contract manufacturing, and in addition will develop further and manufacture its line of pipe-bending machines, as well as a line of special machinery.

Whiting Corporation, Harvey, Ill., manufacturer of cranes and foundry equipment, has purchased a controlling interest in the Grindle Fuel Equipment Co., manufacturer of powdered coal plants for use in connection with steam boilers, malleable furnaces, annealing ovens, and other types of furnaces. The Grindle Fuel Equipment Co. has moved its offices to Harvey, and will continue its business under the same name. The Whiting Corporation will manufacture all Grindle equipment. The following officers have been elected: President, B. H. Whiting; vice-president and general manager, A. J. Grindle; and secretary and treasurer, T. S. Hammond.

Diamant Tool & Mfg. Co., Inc., 95 Runyon St., Newark, N. J., has appointed Russell, Holbrook & Henderson, Inc., 30 Church St., New York City, its exclusive sales representatives, handling Diamant standard punch and die sets in the territory covering New Jersey north of Trenton, all of New York City, New York state south of Kingston, and all of Connecticut west of the Connecticut River. The company has also appointed H. M. Bush, 16 S. Third St., Columbus, Ohio, sales representative for central Ohio, and Russell Propes, 1025 Cherry St., Norristown, Pa., sales representative for southeastern Pennsylvania, including the Philadelphia section.

Wetmore Reamer Co., 60-64 Twenty-seventh St., Milwaukee, Wis., manufacturere of a line of expanding reamers, including cylinder reaming sets, and the **Wisconsin Tool & Supply Co.**, of Milwaukee, manufacturer of special tools, jigs, dies, fixtures, and thread gages, have been consolidated and will hereafter be operated under the name of the Wetmore Reamer Co. The company will specialize in the manufacture of expanding reamers for high-speed and quantity production work, as well as expanding machine reamers under one inch in size, which are a recent development. It will also continue to build tools and dies, fixtures and special thread gages. The officers of the consolidated corporation are as follows: President and general manager, Edward J. Waltzer; vice-president, Charles G. Forster; secretary, Carl A. Forster; and treasurer, Edward D. Johnson. The direct management of the company will be under the supervision of the Wisconsin Tool & Supply Co. organization.

Atlas Vise Co., Lowville, N. Y., has been incorporated, with a capitalization of $25,000, by Foster M. Strickland of Champlain, N. Y., and E. W. Fulton, G. L. Fulton, Henry Petrie, and H. W. Green of Lowville, for the purpose of manufacturing, buying, selling, importing, and exporting vises and tools of all kinds. Executive and sales offices have been opened in the Bowen Block, Lowville. Manufacturing and selling rights under patents owned by E. W. Fulton, former president and general manger of the Fulton Machine & Vise Co. of Lowville, have been secured, as well as similar rights to the trade name and patents of the Velox Vise Co. The vises are now being manufactured for Mr. Fulton by the Porter-Cable Machine Co. of Syracuse, N. Y., and it is expected that the new organization will continue the arrangement and that all shipments will be made from Syracuse. The line of vises acquired includes a new type of combination vise especially designed for garages, and a Velox steel bar quick-action vise more especially adapted to the needs of industrial plants. Standard bench vises will also be carried.